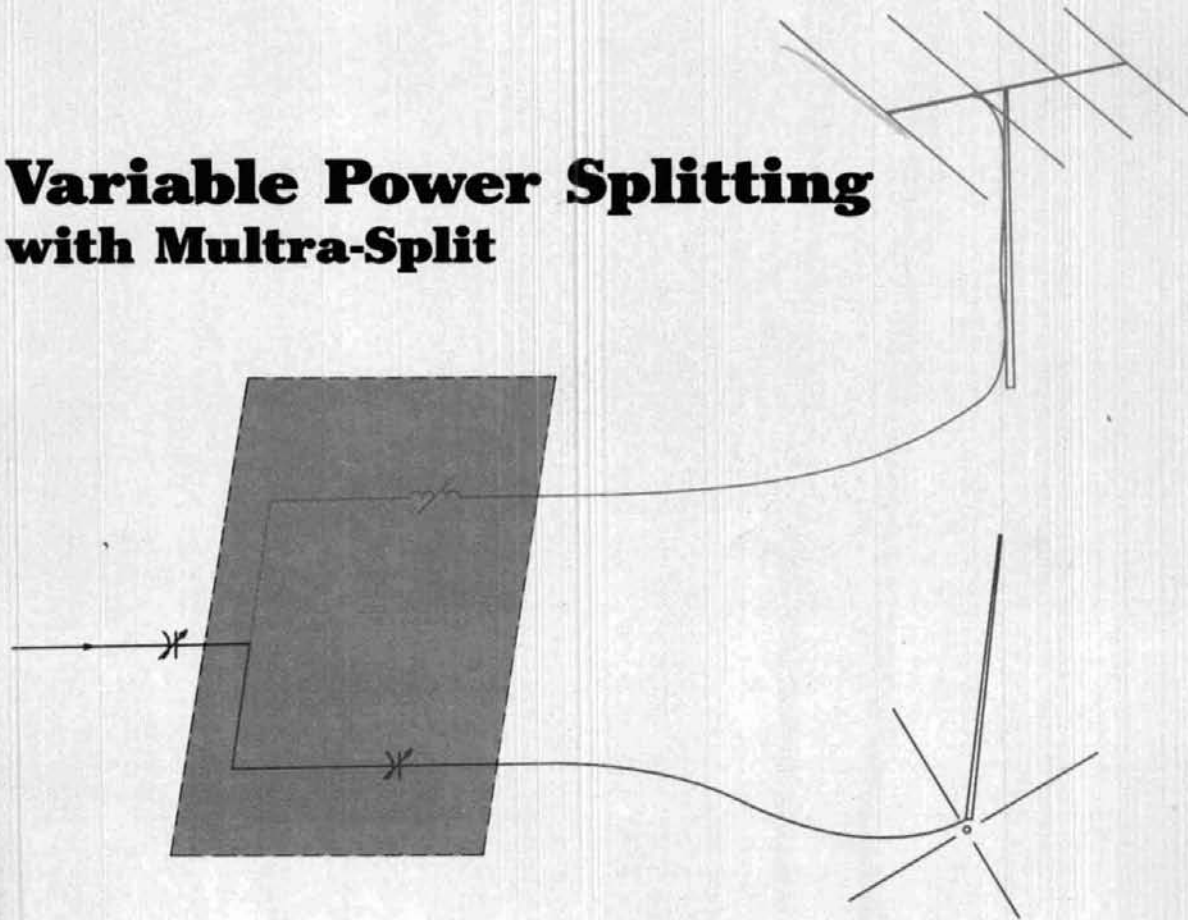


# ham radio magazine

## Variable Power Splitting with Multisplit



**hr**  
focus  
on  
communications  
technology

*cylindrical feedhorns • two-tone signal generator • the offset drooper: an improved ground plane • improving audio on the ICOM IC-27 • EME link calculator program • quartz crystal resonators • plus W9JUV, W1JR, W6SAI, W6MGI, K4IPV, K0RYW*

ICOM HF Transceiver

# IC-751



## The Standard of Excellence in HF Base Stations

The IC-751 is the most advanced transceiver available today. It's a competition grade ham receiver, a 100KHz to 30MHz continuous tuning general coverage receiver AND a full-featured all mode solid-state ham band transmitter. The IC-751 also covers the new WARC bands, MARS frequencies, and is AMTOR compatible.

**Important Standard Features.** Compare these important standard features in this "top of the line" base station:

- 100KHz - 30MHz Receiver
- 105dB dynamic range
- QSK — full break-in CW (nominal speed 20WPM)

- FM Mode Standard
- High-grade FL-44A 455KHz SSB filter
- 32 tunable Memories with lithium battery backup
- 100% Duty Cycle Transmitter
- Passband Tuning
- 12V DC operation
- Adjustable AGC
- Adjustable Noise Blanker
- RIT/XIT with separate readout
- IC-HM12 Microphone with Up/Down Scan
- Continuously adjustable transmit power

**Options.** IC-EX310 speech synthesizer, internal IC-PS35 power supply, external IC-PS15 or IC-PS30 system supply, IC-SM8 two-cable desk mic,

IC-SM6 desk mic, RC-10 external controller, and a variety of filters.

### FILTER SPECIFICATIONS

Filter	Model	Center Freq. (KHz)	-6dB (KHz) Width
<b>STANDARD FILTERS</b>			
AM Ceramic	CFW 455 IT	455	6.0
SSB (PBT) XTAL	FL-30	9011.5	2.3
FM Filter	9M15A	9011.5	15 (-3dB)
SSB Narrow (Hygrade Crystal)	FL-44A	455	2.4
<b>OPTIONAL FILTERS</b>			
CW Narrow	FL-52A	455	0.500
CW Narrow	FL-53A	455	0.250
SSB Wide	FL-70	9011.5	2.8
CW Narrow	FL-32	9010.6	0.500
CW Narrow	FL-63	9010.6	0.250
AM	FL-33	9010.0	6.0

Operating From 12V, the IC-751 is also available with an optional internal AC power supply, the IC-PS35...for the winning edge in field day competition.



Shown with IC-PS35

The IC-751 provides superior performance for all amateur radio operators...from novice to extra class. See the IC-751 at your local ICOM dealer.

Now with a ONE YEAR Warranty!

First in Communications

ICOM America, Inc., 2380-116th Ave NE, Bellevue, WA 98004 / 3331 Towerwood Drive, Suite 307, Dallas, TX 75231

All stated specifications are approximate and subject to change without notice or obligation. All ICOM radios significantly exceed FCC regulations limiting spurious emissions. 75138

# TOO GOOD TO BE TRUE?

## PAKRATT™ Model PK-64

shown with enhanced  
HFM-64 option installed



★ MORSE ★ BAUDOT ★ ASCII ★ AMTOR ★ PACKET ★

### FIRST FIVE MODE DATA CONTROLLER

The Pakratt model PK-64 by AEA is the world's first computer interface that offers Morse, Baudot, ASCII, AMTOR and Packet all in one box (hardware and software included) at a price many competitors charge for Packet alone (from \$219.95 Amateur net). Do not let the low price fool you; coming from any other company but AEA it WOULD be too good to be true. The PK-64 works with virtually any voice transceiver. The Pakratt is the easiest of any to hook up and have operating in just a few minutes.

In Packet mode, the PK-64 offers virtually all the features of every other Packet controller on the market, plus many important features left out by others due to cost constraints. For example, we have included a hardware HDLC, true Data Carrier Detect (DCD), multiple connect with up to ten stations simultaneously and full implementation of version 2.0 of the AX.25 protocol.

Because the PK-64 was designed specifically for the Commodore 64 (or C-128 and SX-64) computer, we have been able to do many things not economically feasible with general RS-232 interface controllers. For ex-

ample, the Pakratt includes true split screen operation with on-screen status indicators and an on-screen tuning indicator.

### ENHANCED HFM-64 MODEM OPTION

The standard PK-64 will operate all modes with a phase-lock-loop (PLL) detector roughly equivalent to all popular packet modems in the marketplace (except we have included extra filtering). The enhanced HFM-64 modem option offers true independent dual channel filtering with A.M. detection (like the famous CP-100 Computer Patch™). The enhanced HFM-64 option also offers a hardware LED tuning indicator (like the CP-100) and a front panel variable threshold control for setting maximum sensitivity under various band conditions. We recommend the HFM-64 option for anyone keenly interested in weak-signal heavy-QRM HF operation. For anyone desiring to operate FM RTTY with the standard North American tone pair or CW receive, the HFM-64 is required. The HFM-64 is field installable with no soldering or test equipment required.

### WORKS WITH THE POPULAR C-64 COMPUTER

AEA designed the PK-64 around the

low-cost C-64 because of the special architecture features making it especially suited to Amateur Radio applications. The C-64 should not be viewed as a mainframe, but rather a very economical accessory to your data communications system. Many owners of expensive computers such as IBM, TANDY, APPLE, KAYPRO, ATARI, etc., are now buying the low cost C-64 and dedicating it to their operating position. They simply cannot find software for their machine that even approaches the power and user friendliness of the PK-64. Plus, think of the convenience of having only one controller and keyboard to go from one mode to another without having to re-do cabling!

The PK-64 is so complete that all you need to do is wire up a microphone connector to the end of a cable (provided) and you are ready to go. There is no need to track down special terminal software, cabling or even a power supply. It all comes with the PK-64. So do not be the last on your block to own the most exciting new product in years. See the PK-64 at your favorite dealer or write for our specification sheet now.

*Prices And Specifications Subject To  
Change Without Notice Or Obligation*

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**AEA** Brings you the  
Breakthrough!



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**NEW!**  
Computer Interface!

## “DX-cellence!”

### TS-940S

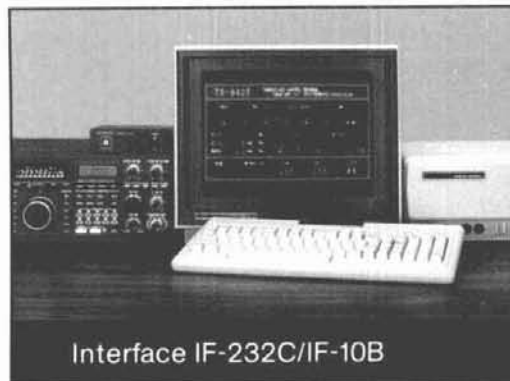
The new TS-940S is a serious radio for the serious operator. Superb interference reduction circuits and high dynamic range receiver combine with superior transmitter design to give you no-nonsense, no compromise performance that gets your signals through! The exclusive multi-function LCD sub display graphically illustrates VBT, SSB slope, and other features.

- **100% duty cycle transmitter.** Super efficient cooling system using special air ducting works with the internal heavy-duty power supply to allow continuous transmission at full power output for periods exceeding one hour.
- **High stability, dual digital VFOs.** An optical encoder and the flywheel VFO knob give the TS-940S a positive tuning “feel”.
- **Graphic display of operating features.**

Exclusive multi-function LCD sub-

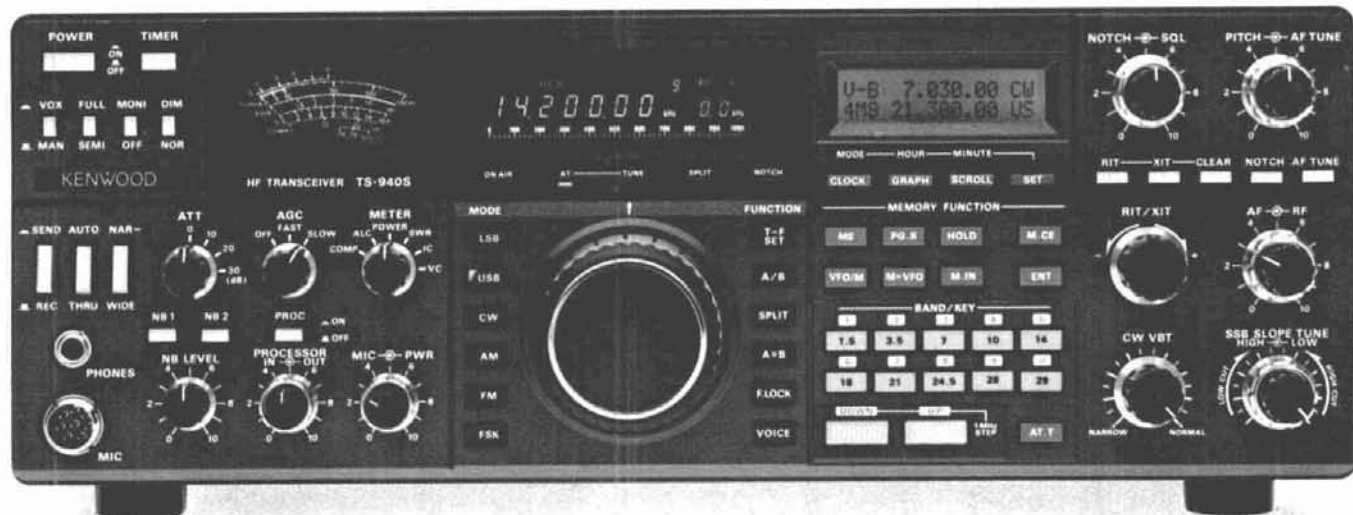
display panel shows CW VBT, SSB slope tuning, as well as frequency, time, and AT-940 antenna tuner status.

- **Low distortion transmitter.** Kenwood’s unique transmitter design delivers top “quality Kenwood” sound.
  - **Keyboard entry frequency selection.** Operating frequencies may be directly entered into the TS-940S without using the VFO knob.
  - **QRM-fighting features.** Remove “rotten QRM” with the SSB slope tuning, CW VBT, notch filter, AF tune, and CW pitch controls.
  - **Built-in FM, plus SSB, CW, AM, FSK.**
  - **Semi or full break-in (QSK) CW.**
  - **40 memory channels.** Mode and frequency may be stored in 4 groups of 10 channels each.
  - **Programmable scanning.**
  - **General coverage receiver.** Tunes from 150 kHz to 30 MHz.
  - **1 yr. limited warranty.** Another Kenwood First!
- Optional accessories:**
- AT-940 full range (160-10m) automatic antenna tuner
  - SP-940 external



Interface IF-232C/IF-10B

speaker with audio filtering • YG-455C-1 (500 Hz), YG-455CN-1 (250 Hz), YK-88C-1 (500 Hz) CW filters; YK-88A-1 (6 kHz) AM filter • VS-1 voice synthesizer • SO-1 temperature compensated crystal oscillator • MC-42S UP/DOWN hand mic. • MC-60A, MC-80, MC-85 deluxe base station mics. • PC-1A phone patch • TL-922A linear amplifier • SM-220 station monitor • BS-8 pan display • SW-200A and SW-2000 SWR and power meters.



Complete service manuals are available for all Tri-Kenwood transceivers and most accessories. Specifications and prices are subject to change without notice or obligation.



More TS-940S information is available from authorized Kenwood dealers.

## KENWOOD

TRIO-KENWOOD COMMUNICATIONS  
1111 West Walnut Street  
Compton, California 90220



# ham radio

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# REFLECTIONS

## a wrong-headed solution for someone else's problem

Anyone who carries on a telephone conversation should have a reasonable expectation that the conversation will be private. That's a concept with which it's difficult to quarrel. After all, like motherhood, apple pie, and the Stars and Stripes, privacy is something that the American citizen takes for granted. For those who'd challenge the right to electronic privacy there are severe penalties against wiretapping and (in the Communications Act of 1934) against the misuse or divulgence of any private communication heard over the airwaves.

However, in the view of the few who are utilizing a relatively small portion of the radio frequency spectrum for a very lucrative business — cellular telephone — that's not good enough. After all the time, money, and technical genius they've invested in developing cellular technology, they've suddenly discovered it's possible for others to eavesdrop on what their customers are saying!

So have they harnessed some of their technical genius to solve this terrible problem? Of course not. They've gone to the place where any and all problems are solved easily and at someone else's expense: Washington, D.C.

And what's the solution that Washington has devised? Very simple. Under the terms of bills presently moving through the U.S. House and Senate, the citizens of the United States will no longer have any fundamental right of access to the radio frequency spectrum. As those bills are written, it will become a crime to listen to any radio frequency unless the government specifically decides the frequency is one to which it will permit the general public to listen.

Bizarre? Of course. Absurd? Certainly, but that's precisely the premise of the "Electronic Communications Privacy Act of 1985." To be sure, the Act will include some exemptions, with the first being, as a matter of course, for "broadcasting." From then on, however, the exemptions will get a bit stickier; the Act's avowed purpose is to "prevent" the casual listener, no matter how innocent his intent, from "intercepting" any radio transmission that is not intended for his ears.

The only exemptions to this blanket closing off of the spectrum to casual listening will be those services specifically excluded at their own request or due to the beneficence of the bill's authors. Since WWV's time signals will probably qualify as "broadcasting," you should be able to continue setting your watch with them, but if your receiver draws a bit off 10.000 MHz and you end up using a nearby unidentified CW signal for code practice, you're going to need a good lawyer if you get caught.

"But Amateur Radio will be one of the exempt services," you may object, "so what's our problem?" That's just it. It isn't *our* problem — it's everybody's problem. Have you ever tuned below the broadcast band to ship-to-shore CW around 500 kHz, to aircraft radio ranges, to the "Lowfers" with their 1-watt rigs on 1750 meters, or to the various odd signals below 100 kHz? Forget it. It's going to be illegal. Have you ever tuned between the international broadcast bands to see what else goes on in the HF spectrum? Forget it. Illegal. Like to hear what's happening at the local airport tower, on marine VHF FM, or the various caboose-to-engine railroad frequencies? Forget it. Illegal!

Of course, some of these frequencies might not be illegal; they might just be included in that hallowed list of exemptions. But do you really want some Congressional staffer in Washington to sit down with a large yellow pad and decide for you each and every frequency he'll let you tune to and which will be forbidden, from DC to light? That's the way the bills are written, and that's the way they're expected to work.

Wrong-headed? This proposal certainly is, because it establishes a position that's precisely 180 degrees contrary to the position firmly established for the American people in the earliest days of radio. That position has, from the very beginning, been that the radio frequency spectrum is a public resource, and with only the very minimum regulation necessary, the right of public access to that spectrum should not be denied.

This right really dates from just after World War I, when the U.S. Navy tried to maintain complete control of the airwaves it had been given when the United States entered the war. When the war began, Amateurs were not only off the air, but also required to take down antennas and dismantle receivers. Within weeks after the war's end, a bill was introduced in Congress to continue Navy control of all radio communications in peacetime, but due in part to Amateur opposition, the bill failed. Nonetheless, it wasn't until April, 1919, that the Navy lifted its ban on Amateur receiving. However, the Navy still wouldn't give up its attempt to retain control of all radio until that September, when a Congressional resolution finally forced it to turn radio regulation back to the Department of Commerce, and Amateurs once again regained the right to transmit.

Though in subsequent years the amount of Amateur spectrum has varied from time to time, the right of Amateur Radio to exist — and for the public to listen to whatever it pleased — was never again seriously challenged . . . at least until now. This isn't because the consequences of unlimited public access to the RF spectrum were not understood; these consequences were addressed in the Communications Act of 1934, which made it unlawful to misuse or divulge information derived from listening to private radio communications. In 1934, at least, the framers of the law were wise enough to realize they could not stop casual radio listening without placing a "Kilocycle Cop" in every household.

So what's really wrong-headed about these bills is their basic philosophy. First of all, they take the position that "We, the elite, have the absolute right to decide what you, the populace, can and cannot do with a radio receiver." With this "right," they take from all of us — SWLs, Lowfers, scanner buffs, Amateurs, and even the guy with a short wave or "public safety" band on his kitchen radio — the right to tune a receiver where it pleases us . . . a right that's existed since before anyone even knew how to tune a receiver.

Furthermore, this proposed law is completely unenforceable. It will succeed only in making criminals out of millions of otherwise honest citizens, while the tiny minority that eavesdrops for illicit purposes will continue to do so with impunity, just as it does today. All this repressive and futile effort, simply to "solve" a problem for a narrow-minded special-interest group with a need to cover up its own self-induced shortcoming — lack of communications security — at the expense of the American people.

This makes me mad — mad enough to tell my Senators exactly how I feel about S-1667 and my Representatives what I think of HR-3378. I hope it makes you that mad, too.

Joseph Schroeder, W9JUV

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...pacesetter in Amateur radio

## Handy Handful...

### TR-2600A/3600A

Kenwood's TR-2600A and TR-3600A feature DCS (Digital Code Squelch), a new signalling concept developed by Kenwood. DCS allows each station to have its own "private call" code or to respond to a "group call" or "common call" code. There are 100,000 different DCS combinations possible.



- **Simple to operate**  
Functional design is "user friendly." Built-in 16-key autopatch encoder, TX STOP switch, REVERSE switch, KEYBOARD LOCK switch, high efficiency speaker.
- **Large LCD**  
Easy to read in direct sunlight or in the dark with convenient dial light that also illuminates the top panel S-meter.
- **Extended frequency coverage**  
Allows operation on most MARS and CAP frequencies. Receive frequency range is 140-160 MHz. (TR-3600A covers 440-450 MHz.)
- **Programmable scan**  
Channel scan or band scan, search for open or busy channels.
- **SLIDE-LOC battery case**
- **10 Channels**  
10 memories, one for non-standard repeater offsets.
- **2.5 watts high power, 350 mW low**  
TR-3600A has 1.5 watts high or 300 mW low.

The Kenwood TR-2600A and the TR-3600A pack "big rig" features into the palm of your hand. It's really a "handy handful"!

Optional accessories:

- TU-35B built in programmable sub-tone encoder
- VB-2530 2-m 25 W RF power amp.
- ST-2 base stand/charger
- MS-1 mobile stand/charger
- PB-26 Ni-Cd battery
- DC-26 DC-DC converter
- HMC-1 headset with VOX
- SMC-30 speaker microphone
- LH-3 deluxe leather case
- SC-9 soft case with belt hook
- BT-3 AA manganese/alkaline battery case
- EB-3 external C manganese/alkaline battery case
- RA-3 2-m telescoping antenna
- RA-5 2-m/70-cm telescoping antenna
- AX-2 shoulder strap w/ant. base
- CD-10 call sign display
- BH-2A belt hook

More TR-2600A and TR-3600A information is available from authorized Kenwood dealers.



## KENWOOD

TR-2600A shown. TR-3600A is available for 70 cm operation.  
Complete service manuals are available for all Trio-Kenwood transceivers and most accessories.  
Specifications and prices are subject to change without notice or obligation.

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THERE IS A THREAT TO AMATEUR RADIO IN THE "COMMUNICATIONS PRIVACY ACT OF 1985" in spite of an assumption by some observers that "exemption" from its provisions is sufficient protection. It could hurt recruitment, since many future Amateurs become interested in Amateur Radio through casual listening of the type the new bill would prohibit. Furthermore, the total government control of the radio spectrum that it imposes would almost certainly be applied to Amateurs in the future. (For additional in-depth discussion of the proposal's far-reaching negative effects, see this month's editorial.)

TWO CONTRADICTORY BAND PLANS FOR THE NEW 33 CM (902-928 MHz) BAND are now in use, following adoption of its own plan by the Southern California Repeater and Remote Base Association (SCRRBA). The SCRRBA plan, adopted at an 11/16 meeting, totally ignores the ARRL's VUAC-developed plan -- despite the League's plan having been developed over a period of several years and having been well advertised, both before and after its adoption early last year. For example, the SCRRBA plan not only incorporates different sub-bands, but different FM channel spacing and repeater offsets! Neither plan accommodates the Japanese 903-905 MHz personal radios, which could provide an initial source of equipment to encourage startup activity on the band.

Further Delays In Occupying The Band Will Result from this conflict, with makers hesitating to develop 33 cm equipment compatible with two conflicting standards. As a result, competition from other services or for other uses for this choice 26-MHz wide band will continue to surface. For example, one petitioner has proposed the FCC permit the use of low-power video links -- for example, VCRs to TV sets -- throughout the band. ARRL has filed strong comments against the proposal, designated RM-5193 by the Commission, on the grounds that such joint use would result in unacceptable mutual interference.

TWO NEW RUSSIAN SATELLITES ARE SCHEDULED TO BE LAUNCHED in the very near future, possibly in early February. The two birds, designated RS-9 and RS-10, are expected to be placed in low earth orbit with approximately 120-minute periods. RS-9 will have a single Mode A (2 meters up, 10 meters down) transponder, but RS-10 promises to be the most technologically sophisticated Russian Amateur space effort yet.

Mode K (15 Meters Up, 10 Meters Down) and Mode I (a never-before-used 15 meters up, 2 meters down) transponders are believed to be included in RS-10, along with the usual Mode A transponder. A 2-meter beacon on 145.557 MHz and another on 70 cm (still pending license agreements) will also be included.

RS-10 Is Reported To Have Successfully Completed Checkout and be ready for launch, but RS-9 has had some problems. If problems are resolved in time, the two birds should be launched together; otherwise, RS-10 could go up alone.

Another ISKRA Satellite Launch, In Connection With Refueling of the Russian Salyut 7 Spacecraft, is also thought to be imminent. If so, a Mode K transponder will be included. Since this is an even lower altitude event, the satellite lifetime could be as short as a month or so and the orbital period no more than about 90 minutes.

A PETITION FOR A 52-54 MHz "PUBLIC DIGITAL RADIO SERVICE" submitted by Don Stoner, W6TNS, has been designated RM-5241 by the FCC. Stoner's proposal would create a highly automated low-power (1-watt maximum) packet computer-to-computer "hobbyist" radio system, using the top half of 6 meters because of its low usage by Amateurs and unsuitability for other purposes due to the TVI potential. He also suggests there'd be no repetition of the CB chaos of 27 MHz in his service, since he proposes no voice communications -- only data. The FCC released its public notice on RM-5241 on 12/6/85, so the closing date for receipt of Comments was 1/6/86.

THE U.S. AMATEUR POPULATION CREPT TO AN ALL-TIME HIGH of 413,642 individual operators as 1985 drew to a close. The breakdown by license class shows Generals most numerous, with 117,082, followed by Advanced (97,781), Tech (83,387), Novice (77,087), and Extra (38,305). California still has more than twice as many Amateurs as any other state (57,151), with New York (25,897), Florida (24,675), and Texas (24,444) in a close race for second.

Biggest Problem Continues To Be The Novice Class, which is the only license class that's failing to grow. At the end of FCC's fiscal 1983 there were 86,781 Novice licenses in force; a year later that had dropped to 80,461. At presstime the Novice ranks had dwindled by almost another 3400 to 77,087. The continued growth of the higher classes demonstrates the VEC program is working well; the failure is in recruiting new blood.

SPREAD SPECTRUM WILL BE AVAILABLE FOR GENERAL AMATEUR USE ABOVE 420 MHz as of June 1, 1986. Though the new mode may be used for essentially any type of Amateur communication, the rules governing its use are extensive and quite detailed. Potential users should refer to Part 97.71 of the Amateur rules, a new section pertaining only to spread spectrum.

73 MAGAZINE HAS BEEN RETURNED TO ITS FOUNDER, WAYNE GREEN, W2NSD, in a surprise move by CW Communications. CW had acquired 73 as part of the package when they bought Green's computer magazines several years ago, and it was well known in the industry that they've been trying to dispose of it for some time. What is surprising is that Green has returned to the helm, since he'd stated on numerous occasions that he believed Amateur Radio is a dying hobby and he no longer had any serious interest in it.

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## TS-130SE HF transceiver

- 80-10 meters including the new 10, 18 and 24 MHz bands. Receives WWV on 10 MHz.
- 200 W PEP/160 W DC input on 80-15 meters. 160 W PEP/140 W DC on 12 and 10 meters.

- Digital display, built-in.
- IF shift circuit.
- Speech Processor, built-in.
- Narrow/wide filter selection on CW and SSB with optional filters.
- Automatic SSB mode selection.
- RF attenuator, built-in.
- Effective noise blanker.
- Final amplifier protection circuit assures maximum

- reliability. Output power is reduced if abnormal operating conditions occur.
- Other features: VOX, CW semi break-in with sidetone, one fixed channel, and 25 kHz marker.

### Optional accessories:

- PS-30 or PS-430 matching power supplies.
- SP-120 external speaker.
- VFO-120 remote VFO.
- YK-88C 500 Hz CW filter.
- YK-88CN 270 Hz CW filter.
- YK-88SN 1.8 kHz narrow SSB filter.
- AT-130 antenna tuner.
- MB-100 mobile mounting bracket.
- MC-30S/MC-35S hand microphones.
- MC-50 desk microphone.



## TS-670 All-mode "Quad Bander"

- Covers 6, 10, 15 and 40 meter bands.
- 10 W output (4 W AM).
- Direct keyboard frequency selection.
- 80 memory channels.
- Programmable scanning.
- IF shift.
- All-mode squelch.

- Noise blanker.
  - Narrow-wide filter selection.
  - RF attenuator.
  - Dual digital VFOs.
- Optional accessories:**
- PS-430 DC power supply.
  - GC-10 general coverage unit, 500 kHz to 30 MHz.
  - VS-1 voice synthesizer.

- FM-430 FM unit.
- YK-88C 500 Hz CW filter.
- YK-88CN 270 Hz CW filter.
- YK-88A 6 kHz AM filter.
- MC-60A deluxe desk microphone.

- MC-80 desk microphone.
- MC-85 multi-function desk microphone.
- VOX-4 VOX unit.
- MB-430 mobile bracket.

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These MFJ 24 hour clocks make your DXing, contesting, logging and SKEDing easier, more precise.

Read both UTC and local time at a glance with the MFJ-108, \$19.95, dual clock that displays 24 and 12 hour time simultaneously. Or choose the MFJ-107, \$9.95 single clock for 24 hour UTC time.

Both are mounted in a brushed aluminum frame, feature huge easy-to-see 5/8 inch LCD numerals and a sloped face that makes reading across-the-shack easy and pleasant.



MFJ-108  
\$19.95

MFJ-107  
\$9.95



MFJ 24 HOUR LCD CLOCK  
MODEL MFJ-107

You can read hour, minute, second, month and day and operate them in an alternating time-date display mode. You can also synchronize them to WWV for split-second timing. Both are quartz controlled for excellent accuracy.

They are battery operated so you don't have to reset them after a power failure, and battery operation makes them suitable for mobile and portable use. Long life battery included. MFJ-108 is 4 1/2 x 1 x 2 in. MFJ-107 is 2 1/4 x 1 x 2 in.

## RTTY/ASCII/AMTOR/CW MFJ-1229 COMPUTER INTERFACE \$179.95



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The MFJ-1229 is a general purpose computer interface that will never be obsolete. An internal DIP switch, TTL and RS-232 ports lets you adapt the MFJ-1229 to nearly any home computer and even operate AMTOR with appropriate software.

A crosshair "scope" LED tuning array makes accurate tuning fast, easy and precise.

You can transmit both narrow (170 Hz) and wide (850 Hz) shift while the variable shift tuning lets you copy any shift (100-1000 Hz) and any speed (5-100 wpm, 0-300 baud ASCII).

Automatic threshold correction and sharp multipole active filters give good copy under severe QRM, weak signal and selective fading.

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MFJ's Portable Antenna lets you operate 40, 30, 20, 18, 15, 12, 10 meters from apartments, motels, camp sites, vacation spots, any electrically clear location where space for full size antenna is a problem.

A telescoping whip (extends 54 in.) is mounted on self-standing 5 1/2 x 6 3/4 x 2 1/4 inch Phenolic case. Built-in antenna tuner, field strength meter, 50 foot coax. Complete multi-band portable antenna system that you can use nearly anywhere. 300 watts PEP.

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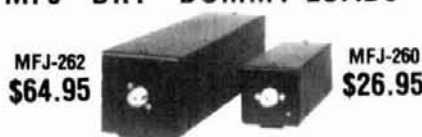


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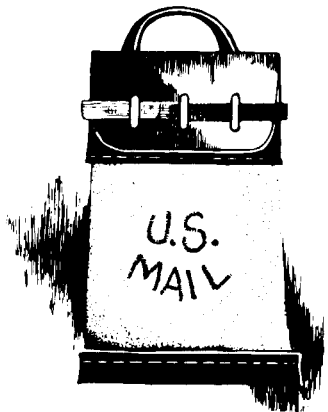
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# comments

## odd antennas

Dear HR:

Those of us who have been hams for 30 years but are not radio engineers sometimes wonder about certain unused antenna designs. Perhaps the expertise of the readership of *ham radio* can enlighten us on these peculiar issues.

For instance, every antenna handbook I own describes the advantages in gain of 5/8-wave verticals and 1.28 wave dipoles, the 1.28 wave dipole having a 3-dB gain over a half-wave dipole (see the Extended Double Zepp, fig. 1). Why aren't more antennas designed using the 1.28-wave element, especially at frequencies above 144 MHz?

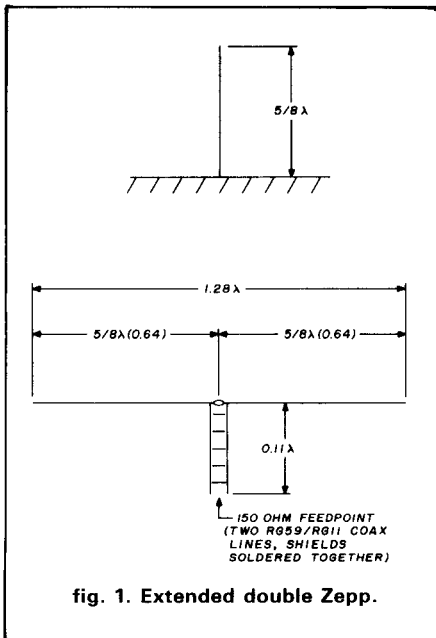


fig. 1. Extended double Zepp.

Every good handbook describes the Windom 14 percent off-center-fed antenna (fig. 2A), normally usable at 1/2, 1, and 2-wave frequencies — three bands. Why aren't multi-band dipoles (fig. 2B) tubular beams (fig. 2C) and quads (fig. 2D) designed for 3-bands per element 14 percent off-center-feed?

And since the Windom 600-ohm feedpoint occurs at 14 percent off-center (or 64 percent from one end) and the high-gain 5/8-wave vertical is a 62.5 percent feed point, why won't a bent-Windom vertical, fed 64 percent up, with a 36 percent horizontal section, produce a near 5/8-wave superior

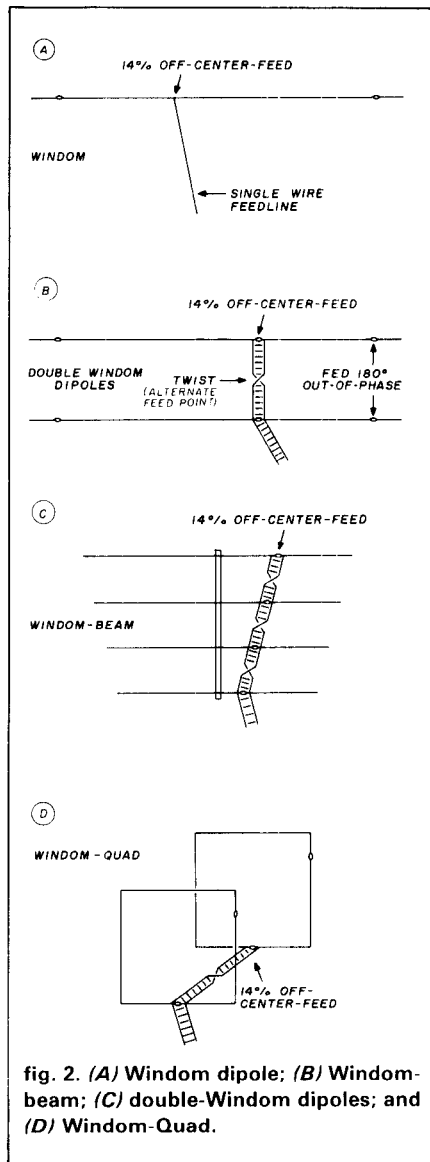


fig. 2. (A) Windom dipole; (B) Windom-beam; (C) double-Windom dipoles; and (D) Windom-Quad.

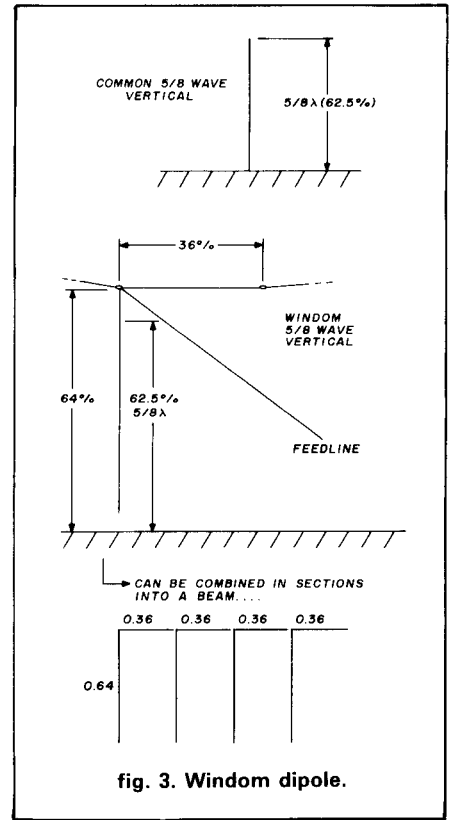


fig. 3. Windom dipole.

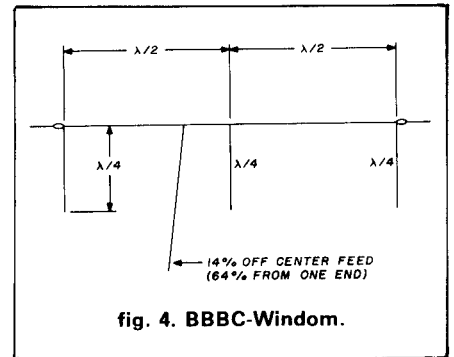


fig. 4. BBBC-Windom.

signal plus a signal on two other bands (fig. 3)?

Since the BBBC (Broadside Bidirectional Bobtail Curtain) (fig. 4) antenna is excellent on one band for DX, why can't it be fed at the 600-ohm off-center Windom feedpoint to make it a multiband antenna?

No doubt there are very good reasons why these antennas do not exist, but a good, logical answer would be gratifying to those of us empirical tinkerers who are theory-deficient.

C.N. Francis, W0MBP  
Silsbee, Texas

# achieve polarization diversity through variable power splitting

Multra-split circuit  
increases signal strength  
and extends  
transmission times

**The reception of high frequency (3-30 MHz) signals** propagated via the ionosphere is characterized at times by irregular and deep fading (indeed, in such places as the auroral zone, by long periods of excessive absorption resulting in communications blackout). This is related to varying amounts of energy in the vertical and horizontal components of the radio wave. A device at the transmitter that takes account of this condition will enhance communications. Power is divided between two transmitting antennas in such a manner that ratios of from 1:1 to 10:1 can be effected without mismatch. In this manner, vertical and horizontal components of the transmission pattern are compensated to prevent fading at the receiving location utilizing radiation angle diversity. A characteristic of the entire propagation phenomenon during altitude changes of the ionosphere is that the horizontal and vertical components never fade simultaneously. Power splitting takes advantage of this characteristic when other parameters of the system have already been optimized. In this way, communications on a particular band may be extended for up to several hours using this technique.

It is generally accepted that an HF antenna with a

low angle of radiation is capable of sustaining usable communications for additional periods as long as two to three hours, during the ionosphere transitional periods.

It is also recognized that during this transitional time some disruption of communications circuits takes place. HF stations normally change their frequencies to re-establish communications. Therefore, any reasonable means that will allow a communicator to extend the transmission period and/or improve the reliability of communications during a transition period, without changing bands, is worth investigating.

During the last 15 years, I have conducted a series of limited experiments on 15 and 20 meters using a transceiver and a pair of antennas. One was a six-element horizontal trap-beam, and the other a vertical antenna. Power from the transmitter was divided between the two antennas by means of a network called *Multra-split*. The *Multra-split* network allowed the power to be divided anywhere from 1:1 to 10:1 without mismatch at the transmitter.

In practice, the antenna with the highest gain is fed the highest power, and generally the higher gain antenna is horizontally polarized. However, depending upon the band of transmission and time of day, it can be more favorable to feed higher power to the vertical antenna.

## sky-wave propagation<sup>1</sup>

At high frequencies, long-distance communication is possible only via sky-wave propagation, whereby radio waves are refracted back to earth from one of the surrounding ionized layers. These layers are the

**By John H. Mullaney, W3NGJ, 9049 Shady Grove Court, Gaithersburg, Maryland 20877.**

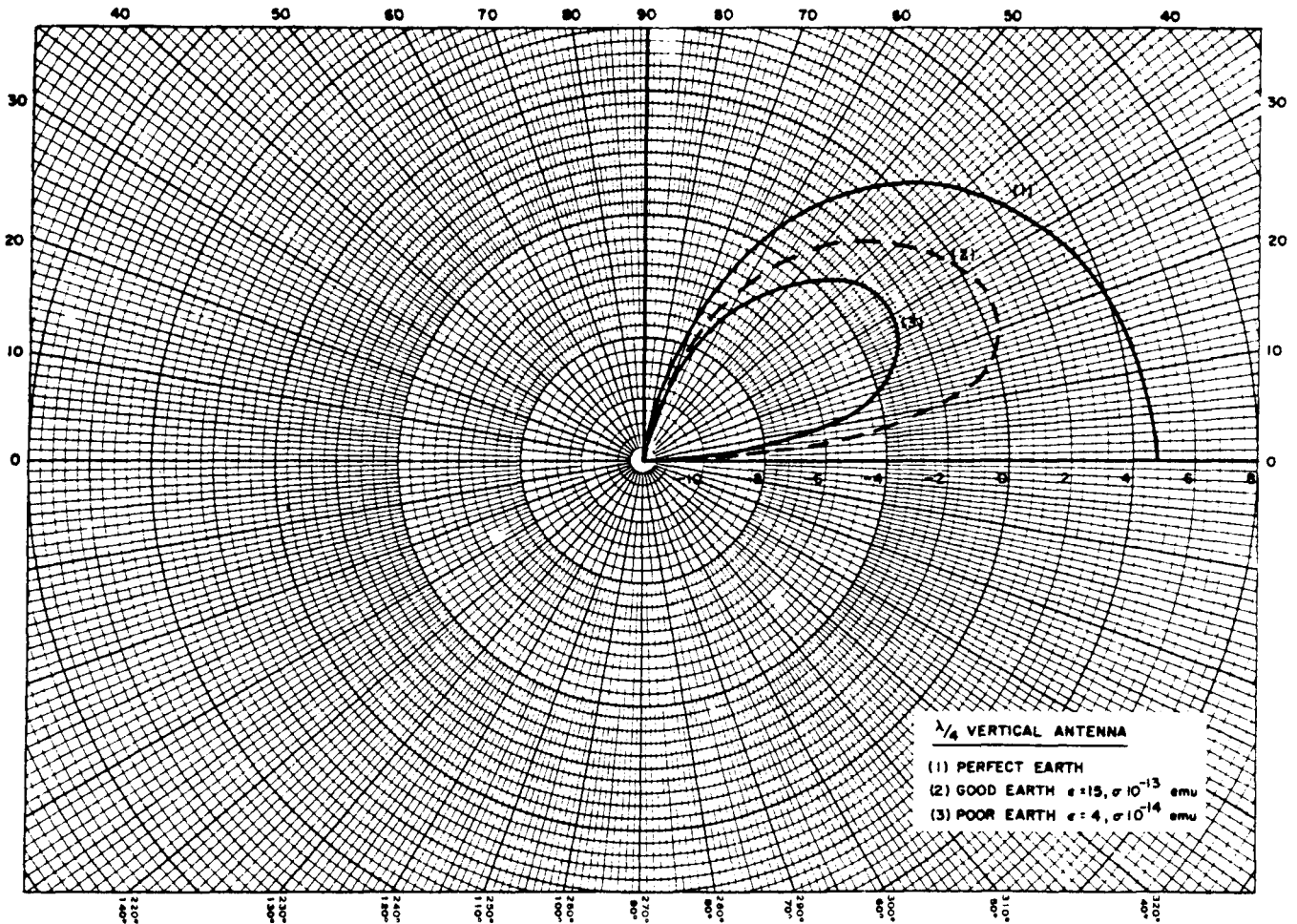


fig. 1. Vertical radiation pattern over earth.

result of ionization of neutral gas in the atmosphere by ultraviolet radiation from the sun.

Because of the variation in the structure of the atmosphere with height and the selective absorption by the various gases of the radiation from the sun, the ionization tends to have several regions of maximum electron density at various heights. These regions are the E-layer, at an average height of 70 miles (113 km), the F1 layer, at about 140 miles (225 km), and the F2 layer, at approximately 250 miles (402 km). Below the E-layer, during the day, is another ionized region at an average height of 35 miles (56 km). This is called the D-region. The D-region accounts for daytime absorption of medium-frequency radio waves. This is the principal reason 80 and 160 are considered night-time bands. These layers, as might be expected (since radiation from the sun is the principal ionizing agent), are present during daylight. At night the D-region is not present, the F1 layer merges with the F2 layer at an average altitude of approximately 175 miles (282 km), and the E-layer essentially disappears.

## polarization

Antennas may be classified as linear elements, apertures, arrays, or traveling wave types. For our discussion, and considering that we are interested in Amateur communications in the 2-30 MHz range, we will deal only with linear and array types.

Two field components are present on an antenna: the magnetic and electric fields. Radio waves, like light waves, can have a definite polarization. Radio wave polarization is determined by the orientation of the electric field component, which in turn is determined by the orientation of the elements themselves.

On a linear antenna or an array of elements, the magnetic field component is always at right angles to the radiator, whereas the electric field component is always in the same plane as the radiator. This means that a vertical antenna or radiator will transmit a vertically polarized wave and a horizontal radiator will transmit a horizontally polarized wave.

Most of the common optical effects experienced



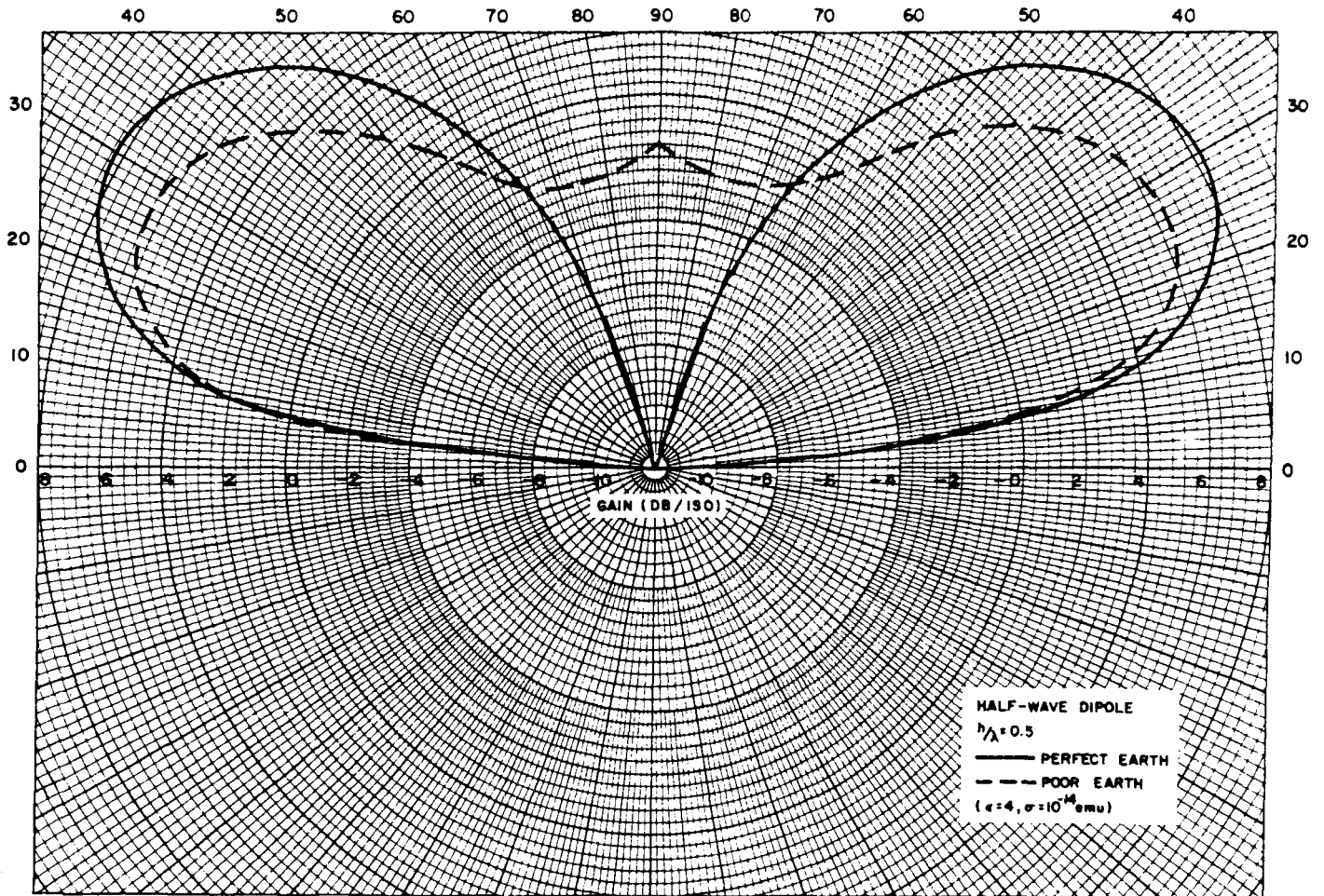


fig. 2. Vertical radiation pattern for horizontal half wave dipole at 180 degrees above earth.

with polarized light also occur between pairs of antennas having different polarizations, when the medium (such as free space) between the antennas does not affect polarization. A linear antenna used for receiving responds most strongly to another antenna with the same polarization, and not at all to one polarized at 90 degrees to the first antenna.

Vertically polarized waves radiated by a vertical antenna over imperfect ground are elliptically polarized because of the presence of a small electric field along the ground in space quadrature and the different time phase from the major electrical component.

For high-frequency ionospheric layer propagation, the received signal is usually elliptically polarized, even when the transmitting antenna produces linear polarization. This condition arises from the effect of the earth's magnetic field on the ionized layers; it splits the incident linearly polarized signal into an ordinary and extraordinary wave. The two waves travel at different velocities and experience different polarization rotations. The resultant received signal is elliptically polarized; consequently, depending on the orien-

tation of the receiving antenna and its height above ground, the received signal may not be usable. The use, therefore, of a vertically and horizontally polarized antenna with a special combining network (such as Multisplit) may provide improved communications not only from a signal strength standpoint, but also over an extended period of time.

The effectiveness of this method of propagation is directly affected by the radiation axis or radiation angle of the antennas used. Whether an antenna is vertically or horizontally excited, its vertical radiation pattern shape is a function of its electrical and physical heights above the ground.

**Figures 1 and 2** show the vertical radiation pattern for a horizontal and vertical antenna.

Note that the vertical shape of the elevation pattern is a function of the earth's conductivity. The lower the conductivity, the more pronounced the distortion to the vertical pattern (high angle signals are hardly attenuated). Either antenna can be selected for the high power side, depending upon transmission path conditions.

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Our new **Digital Voice Recorder** lets you remotely record ID's, tail messages, and various other response messages for automatic playback through your repeater. Audio is stored digitally with no-compromise reproduction quality in up to eight megabits of memory. The DVR can support up to three independent repeaters for a low per-channel cost. Its Touch-Tone activated voice mailbox lets your users easily record messages for other users when they aren't around.

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- Remote base functions including control of synthesized transceiver

- Remotely recordable, variable length audio tracks, accessed from controller messages
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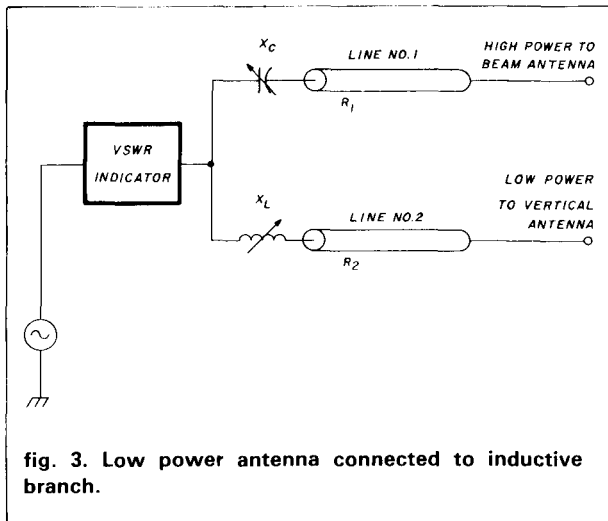


fig. 3. Low power antenna connected to inductive branch.

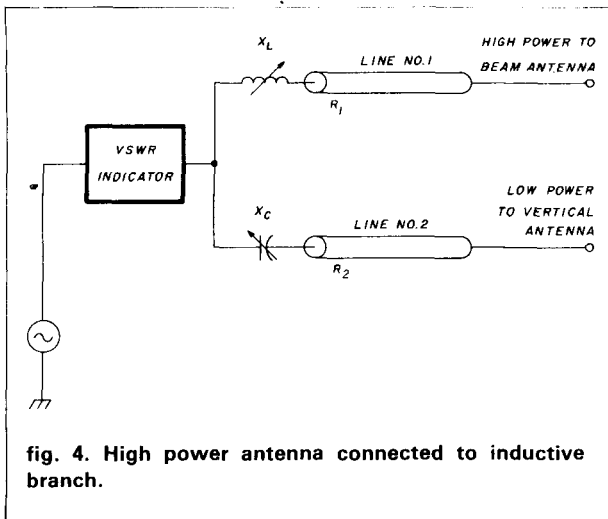


fig. 4. High power antenna connected to inductive branch.

One way to enhance reception and transmission in a varying polarization environment is to use a combiner/power divider network that responds more favorably to the dominant polarization.<sup>2,3</sup> A transmitting type circuit that provides this function (Multisplit) is shown in fig. 3. In this case, two antennas — one horizontally polarized, the other vertically polarized — are fed by a network that splits the power as required. This configuration provides more power to the beam antenna. If the polarization that propagates best is vertical, then the fig. 4 configuration is more appropriate.

### circuit operation

The Multisplit circuit is basically a simple power divider. There are two equal loads (50 or 70 ohms),  $R_1$ , and  $R_2$ , which represent the transmission line resistance for antennas 1 and 2. Reactances  $X_C$  and  $X_L$  are of opposite sign and their values are uniquely determined by the power-division ratio and input

impedance desired. In this case, the input impedance is selected to match the output of the transmitter (50 or 70 ohms). For our discussion, we will assume the use of 50-ohm transmission lines. The power division is determined by the transmission path conditions. Generally, with a high-gain horizontal beam and a vertical whip, the higher power is fed to the beam and just enough power is fed to the vertical antenna to obtain the diversity effect.

The power division can be expressed in terms of a factor  $M'$ , as follows:

$$M' = \frac{P(hi)}{P(low)} \quad (1)$$

where

$P(hi)$  = power to fed to Line 1,

$P(low)$  = power fed to Line 2.

The value of reactance for the high-power leg (Line 1)

is:

$$X = \pm \frac{R_1}{M'} \quad (2)$$

where

$X$  = value of positive or negative reactance in ohms,

$R_1$  = Line 1 resistance in ohms,

$M'$  = power-division factor defined above.

The value of the reactance for the low-power side (Line 2)

is:

$$X = \pm M' \cdot R_2 \quad (3)$$

where

$X$  = value of positive or negative reactance in ohms,

$M'$  = power-division factor,

$R_2$  = line 2 resistance in ohms (must be equal to Line 1 resistance).

It will be demonstrated later that the input impedance will always be equal to the transmission-line impedances, provided certain design requirements are met. This is the same as saying that, under the required conditions, the feedpoint resistance will always remain equal to the load resistance, regardless of the power division between the two branches.

### practical application

Assume a station desired to divide its power on a 90/10 basis; that is, 90 percent in line 1 and 10 percent in line 2. The known parameters are:

$f$  (frequency) = 14.250 MHz.

$P$  (transmitter output) = 500 watts.

$R$  (transmitter output impedance) = 50 ohms.

$I$  (transmitter output current for 500 watts)



$$I = \sqrt{\frac{P}{R}} = \sqrt{\frac{500}{50}} = 3.16 \text{ amperes.} \quad (4)$$

Current in line 1 for 450 watts:

$$I = \sqrt{\frac{450}{50}} = 3.0 \text{ amperes} \quad (5)$$

Current in line 2 for 50 watts:

$$I = \sqrt{\frac{50}{50}} = 1.0 \text{ amperes} \quad (6)$$

Power division factor:

$$M' = \sqrt{\frac{P (hi)}{P (low)}} = \sqrt{\frac{450}{50}} = 3 \quad (7)$$

An inductor is selected arbitrarily for the high power branch. The reactance is:

$$X_L = + \frac{RI}{M'} = \frac{50}{3} = 16.7 \text{ ohms.} \quad (8)$$

Because we selected an inductor for the high power side, a capacitor must be used in the low power branch. Its reactance is:

$$X_C = M' \cdot RI = 3 \times 50 = 150 \text{ ohms.} \quad (9)$$

and since it's a capacitive reactance = -150 ohms. The magnitude of  $X_L$  and  $X_C$  have now been determined. The inductance and capacitance can be readily found. The inductance is:

$$L = \frac{0.159X_L}{f} \quad (10)$$

where

- L = inductance in microhenries
- $X_L$  = inductive reactance in ohms,
- f = frequency in MHz.

solving for L

$$L = \frac{0.159 \cdot 16.7}{14.25} = 0.186 \mu H \quad (11)$$

The capacitance is determined by:

$$C = \frac{159 \times 10^3}{f \times X_C} \quad (12)$$

where

- C = capacitance in picofarads,
- $X_C$  = capacitive reactance in ohms,
- f = frequency in MHz.

Then:

$$C = \frac{159 \times 10^3}{14.25 \times 150} = 74.39 \text{ pF.} \quad (13)$$

The circuit can now be redrawn as in fig. 5.

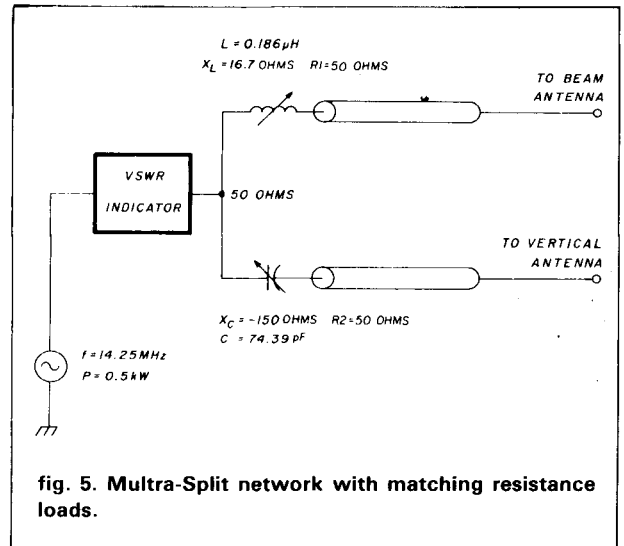


fig. 5. Ultra-Split network with matching resistance loads.

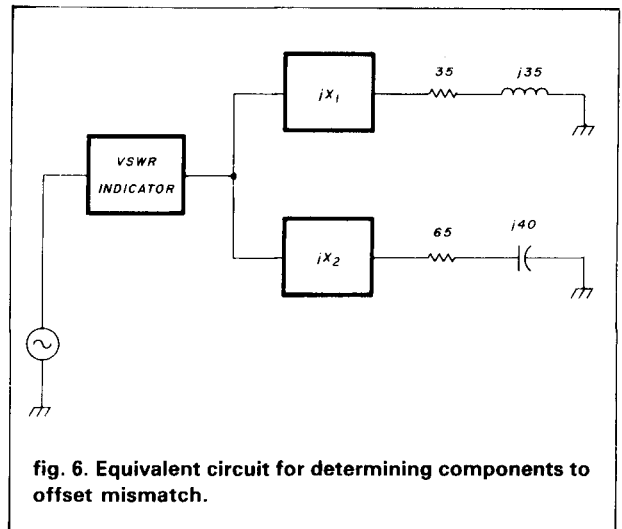


fig. 6. Equivalent circuit for determining components to offset mismatch.

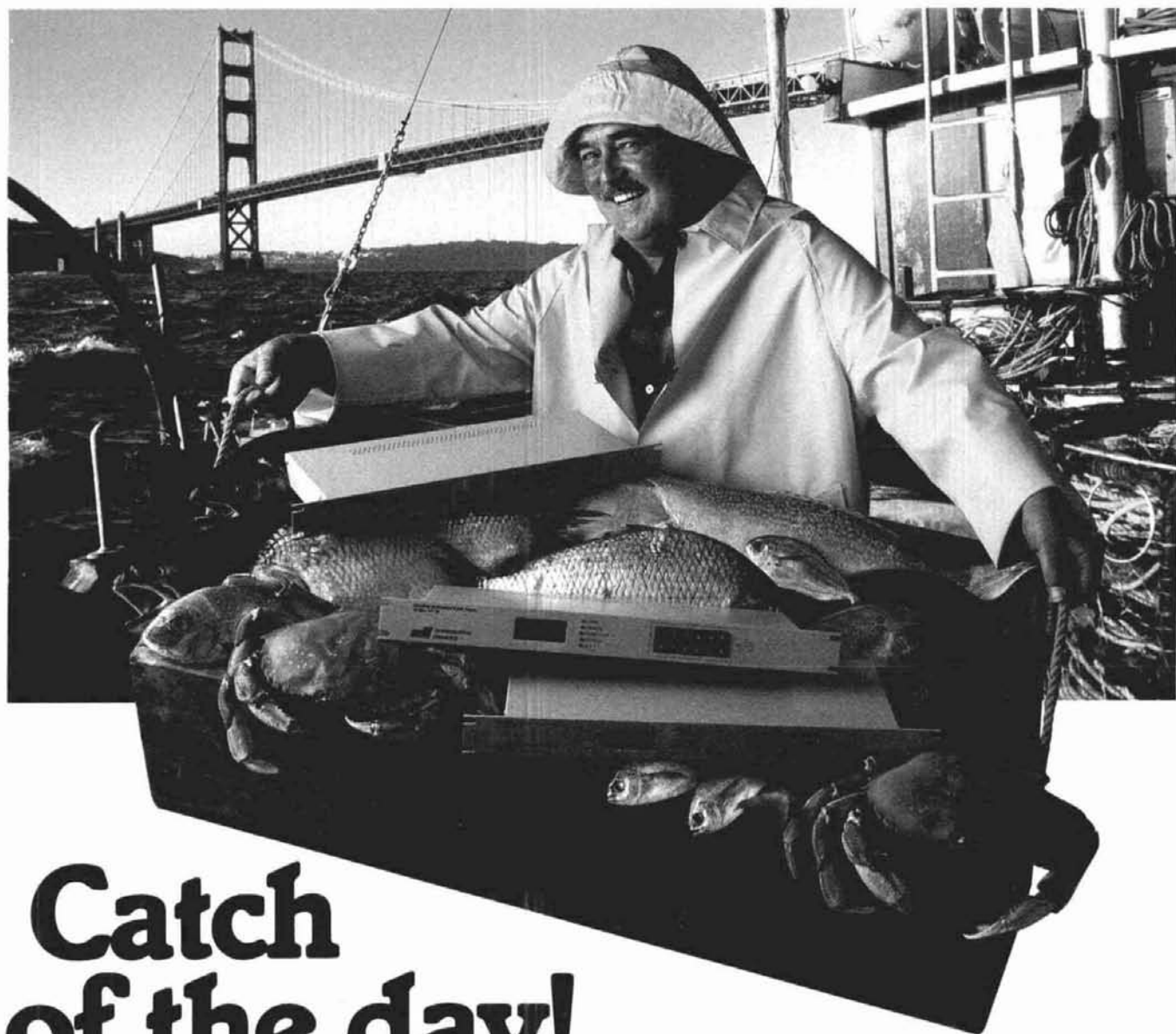
## circuit variations

Combinations of  $X_L$  and  $X_C$  can be selected to accomplish different power splits.

In many cases, it's more practical to use variable capacitors and inductors to obtain the exact power ratio; in others, a fixed capacitor can be made equivalent to a variable unit by using a variable or tapped coil in series with a capacitor.

If you want to operate a transmitter over several bands of frequencies, provisions should be made to switch in different size components. The size and rating of components from a voltage and current standpoint are determined in the usual manner for any network.

It should be noted that the circuit works on the principle that both lines are equal in magnitude and non-reactive. In the event that one or both of the lines are mismatched, it's necessary to adjust the  $X_C$  or  $X_L$  or

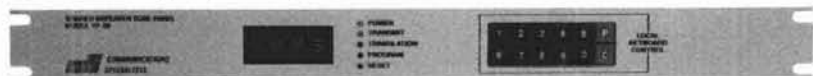


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Other features include CMOS circuitry for low power consumption, non-volatile memory to retain programming if power loss occurs, immunity to falsing, programmable security code and much more. The TP-38 is backed by our legendary 1 year warranty and is shipped fresh daily. Why not set passage for the abundant waters of Communications Specialists and cast your nets for a TP-38 or other fine catch.



**\$595.00 each**  
**\$59.95 DTMF module**

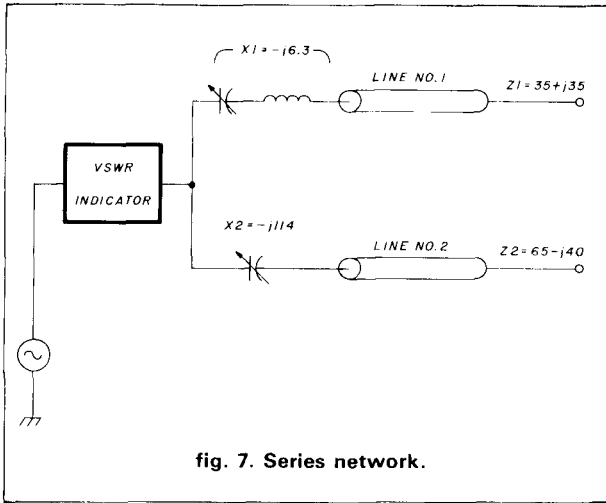


fig. 7. Series network.

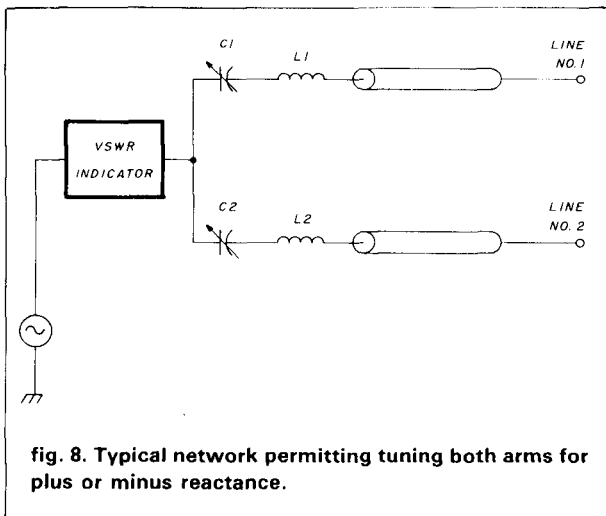


fig. 8. Typical network permitting tuning both arms for plus or minus reactance.

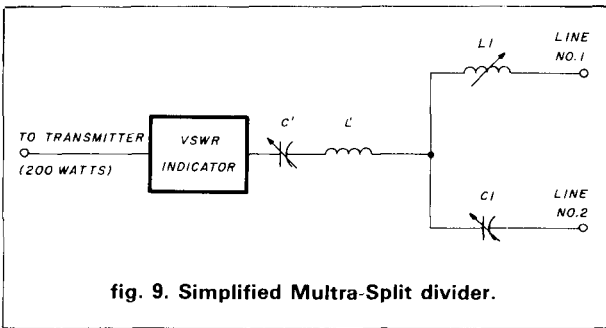


fig. 9. Simplified Multisplit divider.

both to obtain a 50-ohm input for the transmitter. A VSWR indicator at the transmitter output or network input will indicate a match condition.

Where either or both antennas have a large mismatch, the method for determining the combining components becomes somewhat more complex because we have to deal with four variables; that is, two resistances and two reactances. The problem, however, is not too difficult to solve.

Example Assume:

Transmission line 1 =  $35 + j35$ .

Transmission line 2 =  $65 - j40$

Power distribution  $M' = 3.00$  (90 percent/10 percent).

Transmitter impedance 50 ohms.

The equivalent circuit can be represented as in fig.

6.

The values for  $jX1$  and  $jX2$  are of opposite sign and are determined as follows:

$$X1 = \tag{14}$$

$$\left[ \frac{b^2d - 2ea + (b^2d - 2ea)^2 + 4e^2 (b^2c - a^2)}{2 (b^2c - a^2)} \right]^{1/2}$$

where

$X1 =$  net reactance for line 1 (the load reactance),

$$a = R0 - R2 + M'^2 \left( \frac{R2}{R1} R0 - R1 \right)$$

$$b = \frac{2M' R0}{R1 + R2}$$

$$c = R2/R1$$

$$d = R2 R1 \left[ \frac{R2^2}{M'^2} - R1^2 \right]$$

$$e = R1R2 - R0R1 - R0R2 +$$

$$M'^2 \cdot \left( \frac{R2}{R1} \right) \left( \frac{R2^2}{M'^2} - R1^2 \right) \left( \frac{R0 - R1}{R1 + R2} \right),$$

$R0 =$  transmitter resistance = 50 ohms

Substituting the known parameters,  $X1 = j 28.7$  ohms.

Remember that  $X1$  represents the net reactance required for branch one; hence, because we already have  $j 35$  in the circuit we must wash out  $j 6.3$  ohms  $(35 - 28.7) = 6.3$ ) to obtain the required net reactance. This is best accomplished by a series network adjusted to have a reactance of  $-j 6.3$  ohms in series with line 1.

$X2$  is determined from (and will be a negative reactance because  $X1$  is positive).

$$X2 = M' \left[ \frac{R2}{R1} R1^2 + X1^2 - \frac{R2^2}{M'^2} \right]^{1/2} \tag{15}$$

Substitute in Eqn 15  $X2 = -j 154$  ohms. Inasmuch as the reactance for line 2 is  $-j 40$ , we have to add a minus of  $-j 154$  as required by Eqn 15. We obtain this value by using a capacitor which is adjusted to  $-j 114$  ohms.

We can now redraw our circuit as in fig. 7. In practice we should use a circuit that has series networks in both arms because we can adjust these for either

plus or minus reactance, depending upon which side of resonance we are tuned. Fig. 8 is a typical circuit. Due to the fact that we are working with mis-

matched transmission lines, the maximum current and voltages at the input of the lines are determined as follows:

table 1.

Matched condition  
Where R1 = R2 = 50 ohms

P1 percent	X1 ohms	X2 ohms
10	150.00	16.67
20.00	100.00	25.00
30.00	76.38	32.73
40.00	61.24	40.82
50.00	50.00	50.00
60.00	40.82	61.24
70.00	32.73	76.38
80.00	25.00	100.00
90.00	16.67	150.00

table 2.

Mismatched condition  
Where R1 = 35 ohms and  
R2 = 65 ohms

P1 percent	X1, ohms	X2 ohms
10	192.81	12.59
20.00	126.32	18.24
30.00	97.08	28.09
40.00	78.98	38.08
50.00	65.86	48.86
60.00	55.36	61.51
70.00	46.25	77.93
80.00	37.68	102.73
90.00	28.71	153.85

and

$$E_{MAX} = [P \cdot Z_0 \times VSWR]^{1/2} \quad (16)$$

$$I_{MAX} = \left[ \frac{P \times VSWR}{Z_0} \right]^{1/2} \quad (17)$$

where

P = power in watts

VSWR = voltage standing wave ratio,

Z<sub>0</sub> = characteristic impedance of line.

To demonstrate the effect of a mismatch or VSWR vs. a pair of matched lines (Eqns 1, 14, and 15) were used to determine the net reactances required for X1 and X2 for the condition where R1 = R2 = 50 ohms,

table 3.

P1 percent	C1 (PF)3	L1(μH)
10.00	58	0.141
20.00	88	0.204
30.00	115	0.313
40.00	141	0.425
50.00	169	0.545
60.00	202	0.686
70.00	241	0.869
80.00	296	1.146
90.00	389	1.717

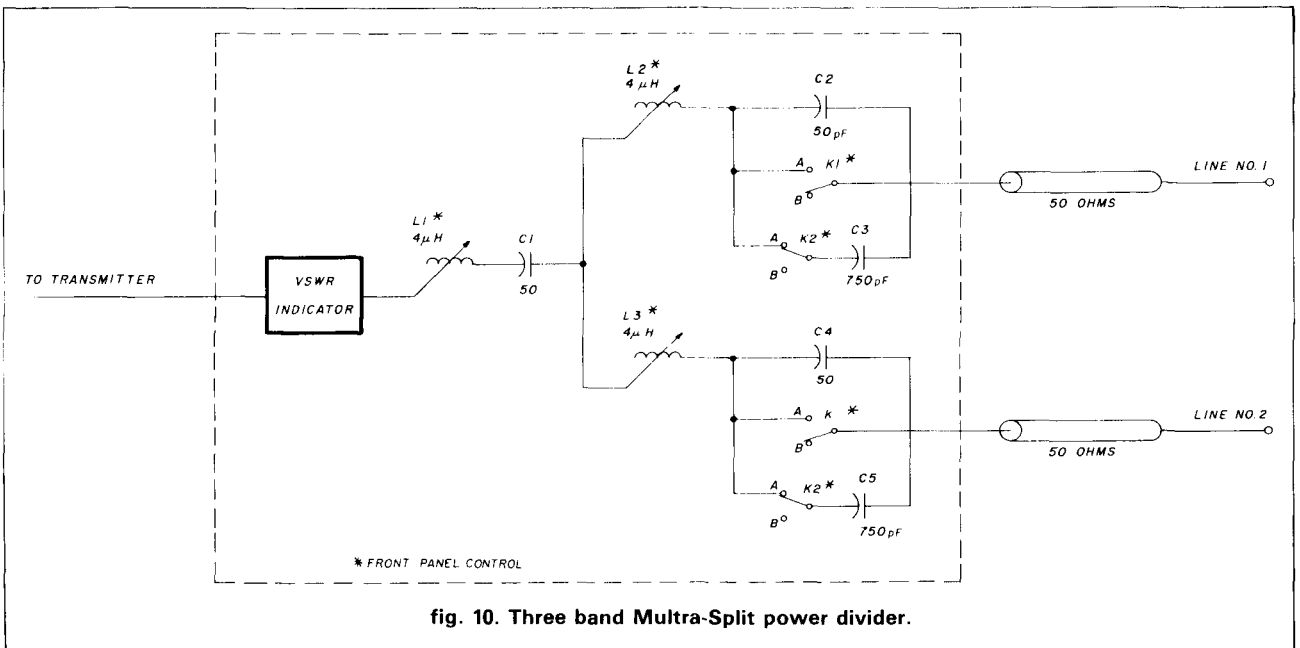


fig. 10. Three band Multisplit power divider.

and  $R1 = 35$  ohms and  $R2 = 65$  ohms. **Table 1** represents the matched condition, whereas **table 2** is for the mismatched condition.

The differences for identical powers is apparent from a study of the tables. In practical applications, series networks in both legs are used with components large enough to handle any mismatch.

### typical multra-split circuits

**Figure 9** illustrates a typical stripped-down version of a Multra-Split power divider for one Amateur band.

$C' L'$  is a series circuit that can be adjusted either side of resonance to wash out any residual reactance due to mismatch on the transmission lines, while  $L1$  and  $C1$  are the components used to control the percentage of power to each antenna.

**Table 3** furnishes typical component values for  $C1$  and for power division from 10 percent to 90 percent where one antenna is a beam and the other a vertical. This divider is for 20 meters with the center frequency being 14.25 MHz. We are using the inductive branch for high power and assume both lines could be mismatched.

$C1$  would be a variable capacitor of approximately 25-400 picoFarad, while  $L1$  would be a variable inductor of approximately 2.5  $\mu$ H. The voltage and current ratings of the components would be determined by the transmitter power and VSWR.

The series circuit  $L' C'$  would consist of a fixed inductor of 4  $\mu$ H, while a variable capacitor of 25-400 picoFarad would be used for  $C'$ .

**Figure 10** illustrates another Multra-Split power divider, used by the author, to cover the bands of 10, 15, and 20 meters. It will handle 1 kW of power.

### conclusions

The Multra-Split network provides a simple method of dividing power between two loads or antennas of identical or dissimilar polarization radiation angles. It can be used to improve HF communications because it works on the principle of taking advantage of radiation angle diversity. Electrically, the principle is straightforward and it should provide a practical economical method for power splitting.

### acknowledgement

Thanks to George Jacobs, W3ASK, for his valuable suggestions and help in preparing this article.

### references

1. G. Jacobs and T. Cohen, *Short Wave Propagation Handbook*, C.Q. Publishing, Hicksville, N.Y.
2. John H. Mullaney, P.E., *Improved H.F. Transmission Reception by Use of Power Splitting*, Multronics, Inc., Gaithersburg, Maryland, June, 1969.
3. John H. Mullaney, "A Method for Pre-Sunrise Power Reduction," *Broad-cast Engineering*, November, 1967.

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# cylindrical feedhorns revisited

Another look  
at this  
popular method

The subject of feedhorn design is obviously of interest to Amateurs and experimenters everywhere; nine years after my first *ham radio* article on this topic, and almost three years after the second, was published, inquiries are still being received.<sup>1,2</sup>

The concept of the open-ended waveguide for use as an antenna or primary feed for a parabolic reflector was covered in the first article; the second article addressed impedance matching to space. Because of limited test pattern facilities, the matter of pattern shape was not thoroughly discussed.

It was only recently that I had an opportunity to make radiation patterns of the cylindrical feedhorn on

a professional pattern range with commercial equipment. These tests were made at frequencies between 3.7 and 4.2 GHz because the feedhorns were designed for that frequency range. The results, however, apply equally well on Amateur frequency bands such as 1296, 2304, 5700 and above, wherever parabolic reflectors would normally be used.

A scalar feedhorn is generally defined as one employing an RF "choke" mounted on the outside of the horn near the open end. Commercial feedhorns often employ chokes consisting of four to six concentric rings, either diecast or milled from a block of aluminum. The purpose is to choke off currents that would otherwise flow on the outside surface of the horn, thereby producing unwanted radiation and power loss. A photograph of a typical scalar feedhorn choke is shown in **fig. 1**.

A scalar choke can be fabricated for use at Amateur frequencies by forming copper strips into concentric circles and soldering them onto a brass washer. The height of the strips should be slightly less than a quarter wavelength, spaced approximately 0.2 wavelengths. The latter is not critical, but care should be taken to assure that the circles are concentric.

The choke shown in the second article was a large flat brass washer soldered to a short cylinder that slid over the outside of the horn for positioning. This type of choke is very effective in improving horn efficiency, and is much easier to fabricate than the scalar choke.

Radiation patterns recently made show that the pattern shape using the flat choke is slightly asymmetrical at some frequencies, causing a few degrees of "squint." That is, the axis of the beam tends to be off the horn axis, and this tends to vary with frequency, as shown in **fig. 2**. The shape of the pattern, and in particular its symmetry, is highly important in terms of overall antenna efficiency when a feedhorn

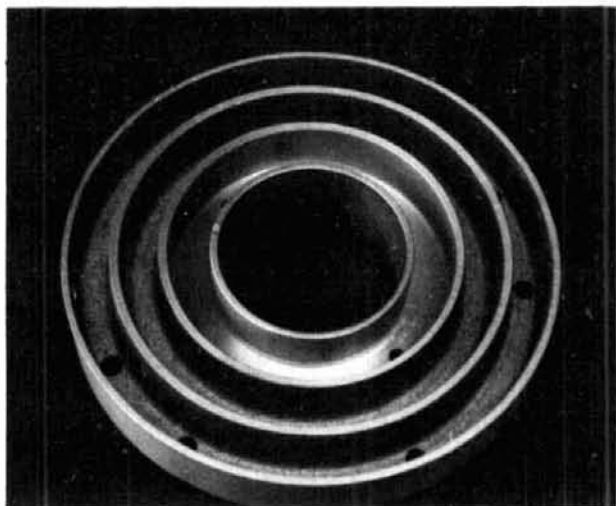


fig. 1. Photograph of typical scalar choke.

By Norman J. Foot, WA9HUV, 293 East Madison Avenue, Elmhurst, Illinois 60126

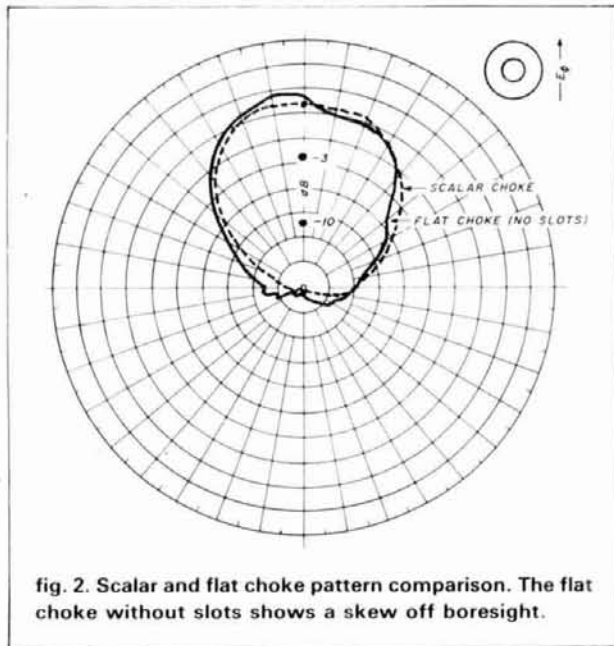


fig. 2. Scalar and flat choke pattern comparison. The flat choke without slots shows a skew off boresight.

is used together with a parabolic reflector, especially when used over an appreciable frequency band.

### overcoming squint

The addition of a single set of resonant slots cut into the choke overcomes the squint problem. The slots act as RF chokes in a manner similar to the concentric rings of the scalar choke. With the addition of the slots, squint is removed and patterns are smooth and axially symmetrical. **Figure 3** is a photograph of a flat choke with slots. Thus, while the addition of a flat choke to the cylindrical feedhorn produces a good match to free space, the slots choke off residual currents that would otherwise flow on the outside of the horn and result in squint. **Figure 4** and **5** compare the patterns of a feedhorn employing a scalar choke with the same horn using a slotted choke. Boresight gains are identical, and 3 and 10-dB beamwidths are for all practical purposes identical. **Figure 4** also shows what can happen when the choke is not used.

### slot orientation function of polarization

In operation, the slots are oriented along the direction of polarization. When used with vertical polarization, the slots are located one above the other. Rectangular slots cut in a conducting ground plane are sometimes used as radiating antennas; they are normally excited by connecting a coaxial cable across the small dimension. The resulting RF current tends to flow parallel to the large dimension of the slot. The slot performs like a dipole except that the directions of voltage and current are reversed. The long dimension is approximately equal to a half-wavelength.<sup>3</sup>

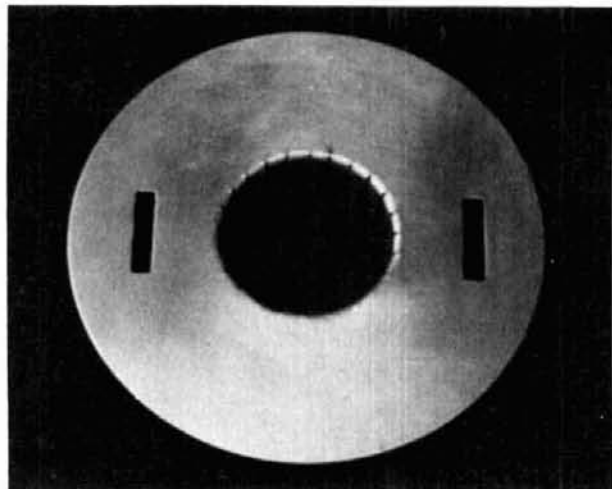


fig. 3. Photograph of slotted choke.

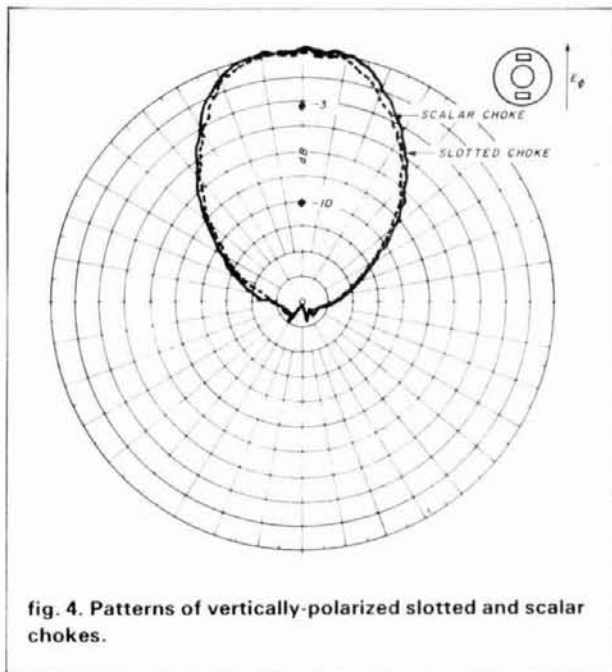


fig. 4. Patterns of vertically-polarized slotted and scalar chokes.

When currents flowing radially outward on the flat choke encounter slots oriented in the wrong direction (i.e., normal to the direction of slot current flow), the current tends to be inhibited and the slots act like RF chokes. Choking action is most effective when the slots are resonant at the RF operating frequency. The slots for use at 4 GHz were cut 1.4 inch long and 0.25 inch (3.17 x 0.63 cm) wide. The slot width is not critical as long as it is much smaller than a wavelength.

If the antenna system uses both horizontal and vertical polarization, such as is the case with TVROs two sets of slots should be used to avoid having to rotate the choke 90 degrees to change polarization. A choke of this kind is illustrated in **fig. 6**. Not shown are a

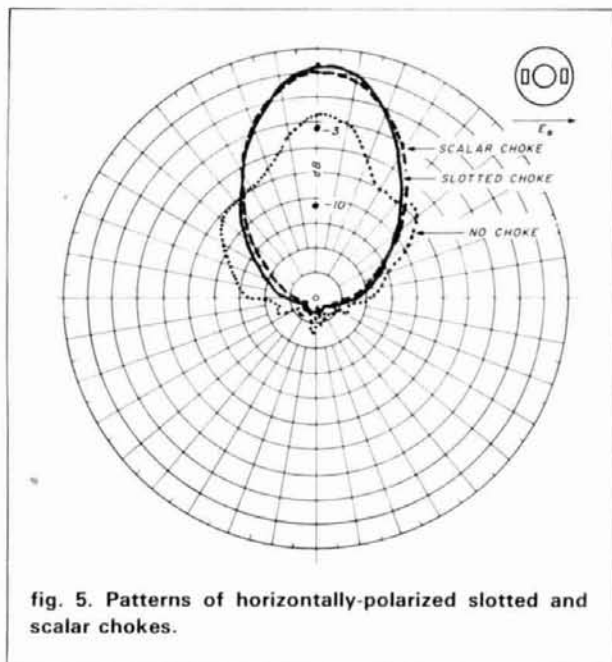


fig. 5. Patterns of horizontally-polarized slotted and scalar chokes.

pair of orthogonally mounted monopoles inside the horn, each of which responds to its respective polarization. Two sets of slots would probably work well with circular or cross-polarization as well, although this has not been confirmed by test.

### choke dimensions

The 4 GHz choke shown in fig. 3 has a 7-inch (17.8 cm) OD and a 2-1/2 inch (6.35 cm) diameter hole at its center which slides over the 2-1/2 inch (6.35 cm) OD horn. The inside diameter of the horn is 2-1/4 inches (5.72 cm) and it is 4 inches (10.16 cm) long. A mechanical drawing of this choke is illustrated in fig. 7. In the pattern tests, the optimum location for the slotted choke was found to be in the plane of the open end of the horn. Pushing the choke forward had very little effect on the gain or patterns, but gain falls off somewhat as the choke is moved to a position behind the horn opening.

Choke dimensions can be scaled for operation at other frequencies. The 2304 MHz choke should be 12 inches (30.48 cm) OD and the center hole should be slide-fit with the 3.9 inch (9.91 cm) diameter of the horn. One-pound coffee can make ideal horns for 2304 MHz, since their ID is slightly less than 4 inches (10.16 cm). The choke slots should be 2-1/2 inches (6.35 cm) long and about 3/8 inch (0.95 cm) wide.

At 1296 MHz, the choke diameter becomes relatively large. If scaled from fig. 7, it would be 21 inches (53.3 cm). To avoid excessive shadowing, especially when using a relatively small dish, a choke diameter as small as 18 inches (45.72 cm) provides reasonably good performance at 1296 MHz.

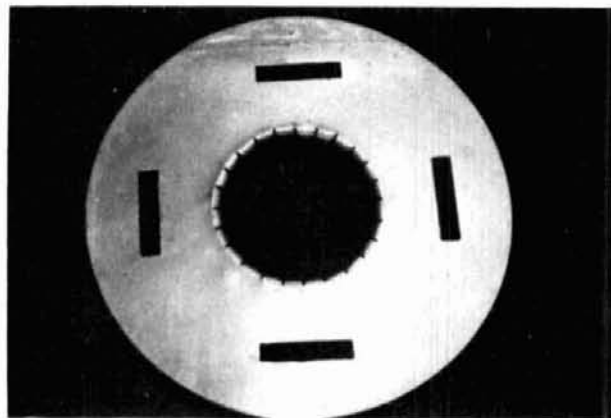


fig. 6. Double slotted choke.

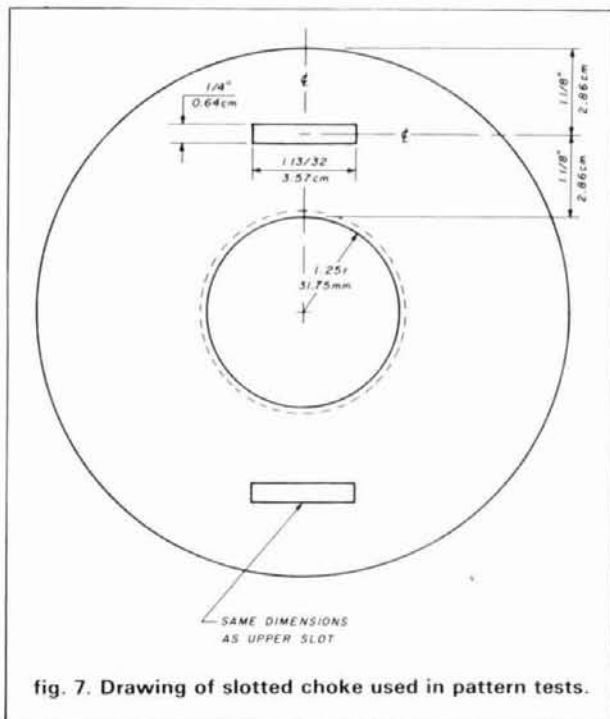


fig. 7. Drawing of slotted choke used in pattern tests.

A 7/8-inch (2.22 cm) ID brass tube makes an ideal horn for the 10.0-10.5 GHz band. The choke should be 2.7 inches (6.86 cm) OD with 9/16 x 1/8 inch (1.43 x 0.32 cm) slots.

Reader inquiries may be addressed to Footronics Engineering Inc., 293 East Madison Avenue, Elmhurst, Illinois 60126, in care of WA9HUV. Please enclose an SASE.

### references

1. Norman J. Foot, WA9HUV, "Cylindrical Feed Horn for Parabolic Reflectors", *ham radio*, May, 1976, page 16.
2. Norman J. Foot, WA9HUV, "Second Generation Cylindrical Feedhorns," *ham radio*, May, 1982, page 31.
3. John D. Kraus, W8JK, *Antennas*, McGraw-Hill, New York, 1950, page 353.

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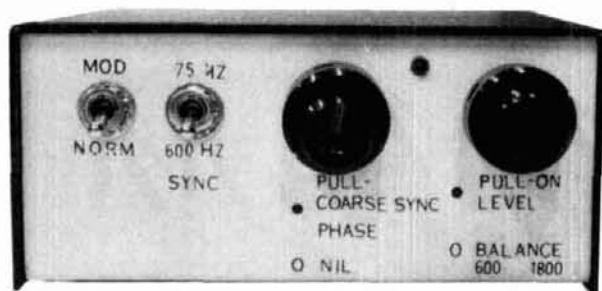
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## two-tone signal generator

Check linearity  
of SSB transmitters  
with an easy-to-read  
oscilloscope display

This article describes a two-tone test generator for checking SSB transmitter linearity. In addition to supplying two low-distortion audio tones to the microphone input of a transmitter, it has three additional features. The first permits the generation of a "bow tie" display on an oscilloscope in which linearity shows up as a straight line, which is easily judged, rather than as two interlaced sine waves, which are not so easily judged. The second feature modulates the level of the two tones at a pseudo voice rate, permitting operation at voice average power levels while viewing a two-tone. (Some transmitter power supplies "droop" during single-tone or even two-tone operation, reaching their peak power output only with a voice waveform with its corresponding low average power.) The third feature is crystal control of the frequencies, which permits accurate frequency measurement of a transmitter without the necessity of generating the carrier.

This generator was conceived as a school project almost 20 years ago. Assigned to build a circuit board, we made a two-tone generator that used two twin-tee oscillators, with the high oscillator locked to the third harmonic of the low oscillator with a small capacitor. When the output of the low oscillator, through a phase shift network to compensate for phase shift in the transmitter, was fed to the X input of a scope and the transmitter output was fed to the normal Y input, a

"bow tie" pattern resulted, making judging distortion easy. But the tones had significant distortion and the third harmonic lock was unstable. Over the years I tried to improve it by various means, including the use of function generator ICs. This design, which offers maximal features but minimal complexity, is the final product.

### operation

For normal operation the output is connected to the microphone input or phone patch input of the transmitter (see fig.1). The oscilloscope is usually connected to the RF output via an X10 probe; the RF output is then connected to a 50-ohm dummy load. Turn the transmitter and the test generator on and adjust the balance and level controls for minimum valleys and peak output as shown in fig. 2A. The switches should be in the "normal" and "600 Hz" positions. The scope output may be connected to the "external trigger" or "channel B" input to the scope and used to synchronize the display. Varying the phase control will shift the display horizontally.

For a "bow tie" pattern, shift the scope output of the generator to the X input of the scope. Adjust the X channel gain for full horizontal display. With the transmitter on, a pattern similar to fig. 3 should occur. Rotate the pattern with the phase control to produce a "bow tie" pattern similar to the one shown in fig. 2B. (Figure 2B was taken with a commercially built Amateur transceiver and appears to be perfect, yet slight variations in linearity are clearly visible in the "bow tie" pattern of fig. 2B.) Figure 4A shows a pattern produced by a transmitter with severe crossover distortion caused by low screen grid voltage and fig. 4B depicts the same with a "bow tie" display. Figures

By Bill McLagan, YB9ATA/WA7AQN,  
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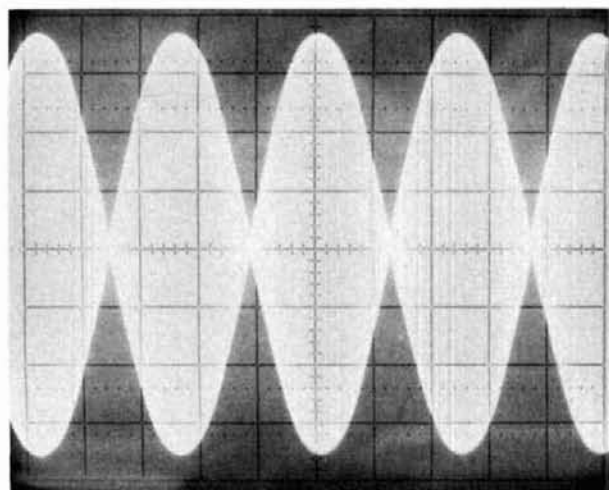
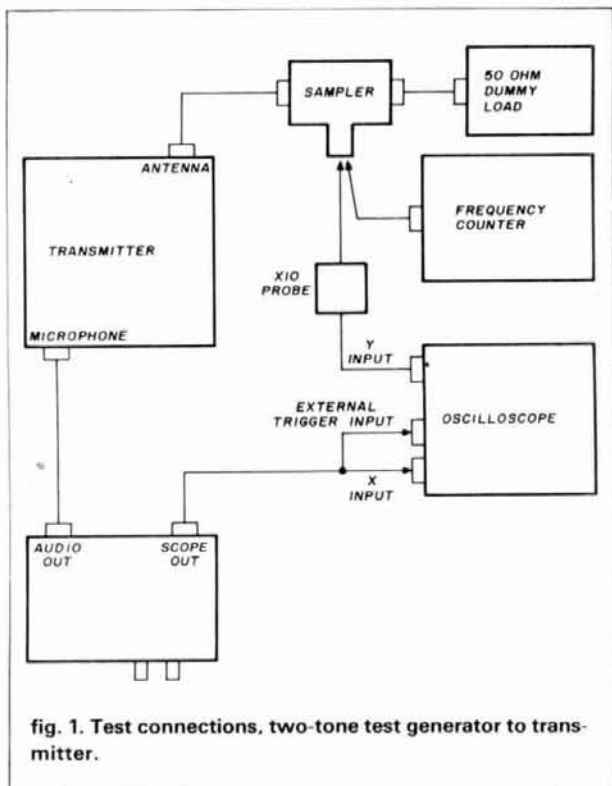


fig. 2A. Output of a commercial transceiver, standard two-tone pattern.

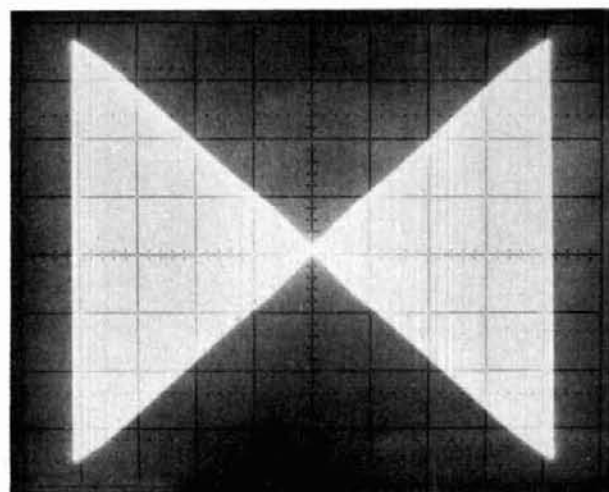


fig. 2B. Output of a commercial transceiver, bow tie pattern.

table 1. Measured power output of a transceiver under test.

Single tone	120 watts
Two-tone	60 watts
Two-tone, pseudo voice	15 watts
Voice ("e" as in "hello")	15 watts
Voice, as above, 20 dB compression	50 watts

5A, 5B, 6A, and 6B show two different kinds of distortion and the resulting patterns.

Figure 7 shows a display using the "modulated" feature to reduce the average power to that encountered during modulation. The synch switch is changed to 75 Hz to synchronize the display. Relative power levels for each mode as measured on a commercially built Amateur transceiver are shown in table 1.

For precise frequency measurement, a single tone is fed into the transmitter. The audio frequency is added to (for LSB) or subtracted from (for USB) the counter reading to arrive at the correct carrier frequency.

### theory, digital section

U1, a CD4060, contains an oscillator and a 14-stage binary divider. Y1 can be either a 3.579545 TV crystal (producing output frequencies of 582 and 1746 Hz) or

a 3.6864 crystal (producing output frequencies of 600 and 1800 Hz). The tenth binary stage puts out a 3600 Hz square wave, which is fed to U3, a CD4017 decimal counter set up to reset on the third count, resulting in a 1200-Hz asymmetrical square wave.

Both the 3600 Hz signal and the 1200 Hz signal are divided by two by U2 to produce 1800-Hz and 600-Hz symmetrical square waves. The 1800 Hz signal is locked to either the leading or trailing edge of the 600 Hz wave via differentiator C17 and R4, which triggers the reset input of the 1800 Hz divide-by-two section. S4 permits triggering from either the Q or  $\bar{Q}$  output of the 600-Hz divide-by-two. This insures that the generator will always start up with the same phase relationship and permits changing the phase 180 degrees to compensate for the less-than-360 degree phase shift available from the "fine" phase control. U7 further divides down the signal to provide 75 Hz

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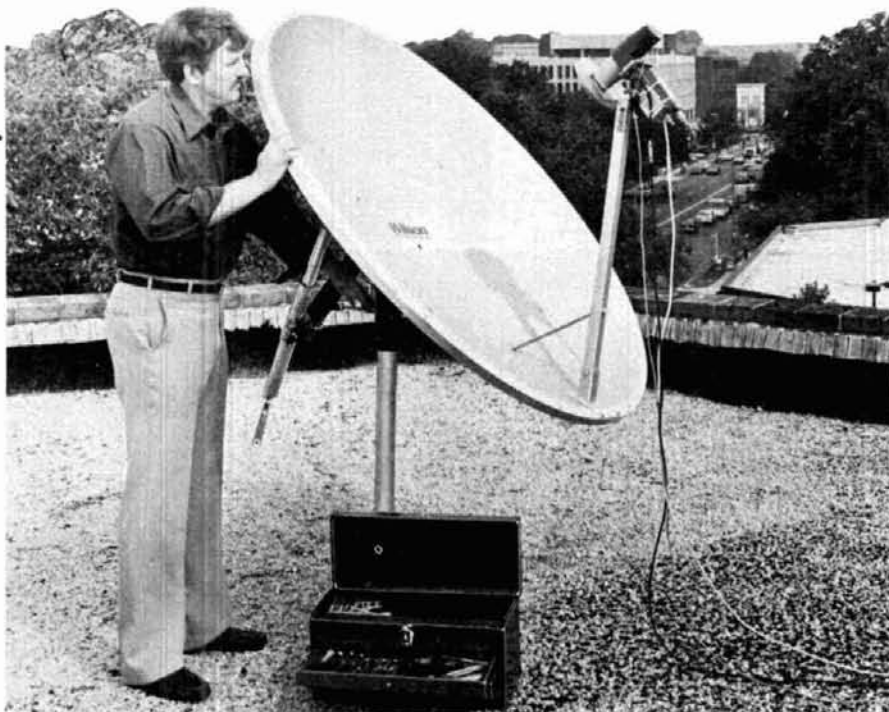
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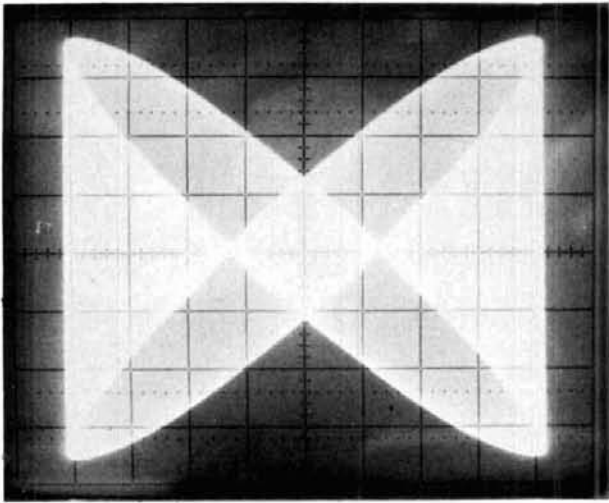


fig. 3. Bow-tie pattern before adjustment of phase control.

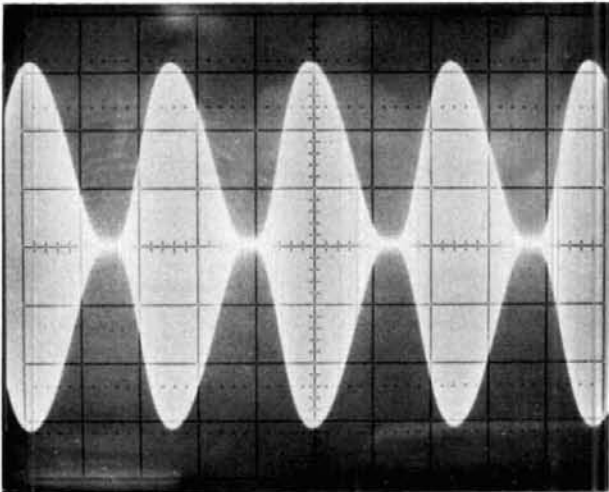


fig. 4A. Severe crossover distortion, standard position.

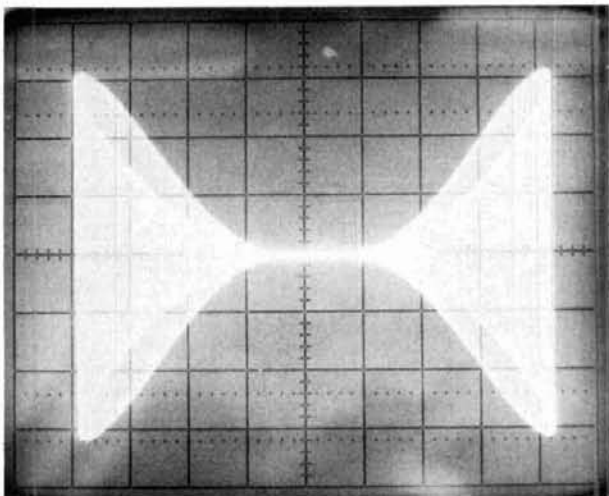


fig. 4B. Severe crossover distortion, bow-tie pattern.

for the modulator and 0.146 Hz for the LED "on" indicator. The LED flash provides a visible indication of the operation, yet avoids the 10- to 20-mA drain of a steady lamp.

### theory, analog section

R5, C5, R6, and C6 provide two poles of lowpass RC filtering to reproduce a near sine wave of 1800 Hz. I've found that when converting a fixed frequency square wave to sine that multiple RC lowpass sections, operated well beyond cutoff and followed by an op amp to recover gain, is simple and effective. In this case, very low distortion is needed so U4B is configured as a multiple-feedback bandpass filter. U4A is set up similarly, but for the 600 Hz channel. The series resistors in the RC sections may have to be changed slightly to adjust for equal gain through each channel and/or set the output of the bandpass filters

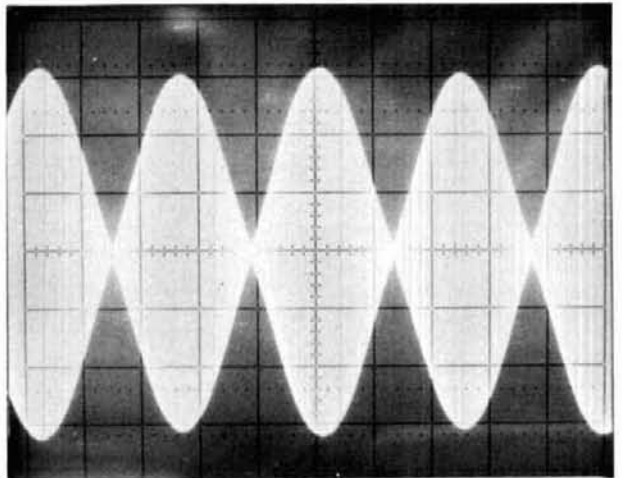


fig. 5A. Minor distortion, higher levels emphasized, standard pattern.

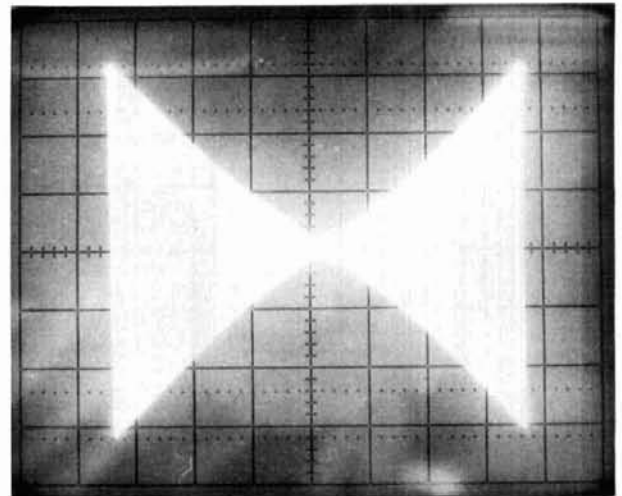


fig. 5B. resulting bow-tie pattern.



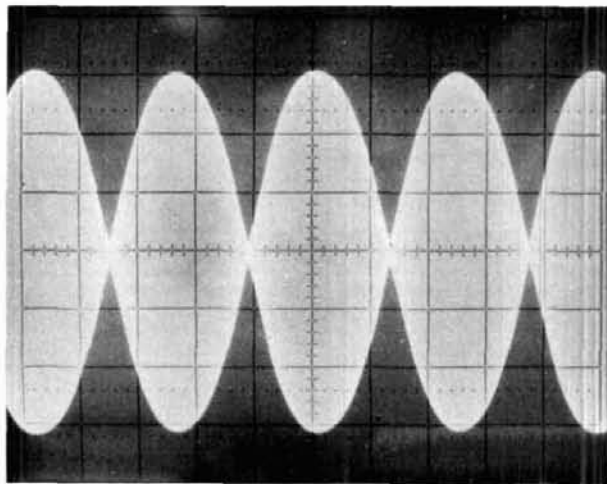


fig. 6A. Minor distortion, higher levels deemphasized, standard pattern.

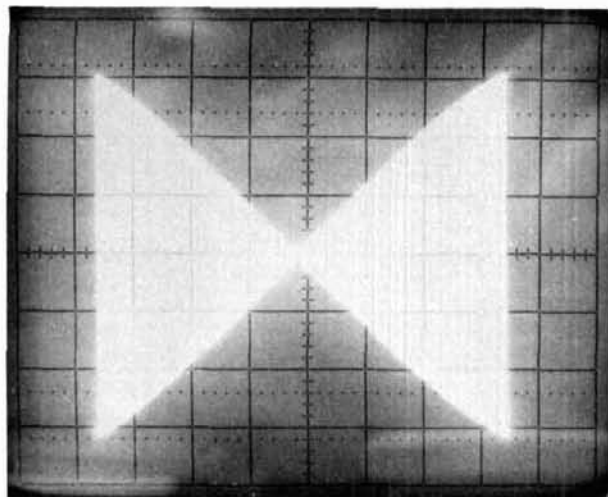


fig. 6B. Resulting bow-tie pattern.

to approximately 1 volt RMS. Both signals are mixed together at the balance potentiometer and go to the transmitter through a voltage follower, U4C, and the level control. Up to this point, the circuit is similar to any conventional two-tone generator.

To obtain the "bow tie" pattern, the low tone must be sent to the X channel through a phase shifter to compensate for phase shift in the transmitter. U4D inverts the 600 Hz tone and feeds one side of phase shift network C13 and potentiometer R20. Nearly 360 degrees of phase shift is possible. Voltage follower U5B presents a high impedance load to the output of the phase shift network and drives the scope isolation transformer, T1. Note that the secondary of T1 is kept floating from the chassis. Without DC isolation, severe problems with ground loops often occur. Care must also be taken with oscilloscopes that have a simple X input because they can be easily overdriven by the several volts available at the scope output. A 500-ohm to 500-ohm transformer could be used as well.

To provide the modulated function, the 75 Hz square wave is converted to a near sine wave by three poles of RC filtering followed by gain recovery stage U5A. The 75 Hz signal enters the AGC input of U6, varying the output at a 75 Hz rate.

### construction

I built the prototype using perf board, IC sockets, and point-to-point wiring using 30 gauge wire. Later I made a circuit board. Either way works fine. In the unit shown (see photo 1), I used some exotic dual-section pots with push-pull switches from my junk box, but normal pots will work just as well. I also added an extra 9-pin plug to allow the use of individual adapter cables to various transceiver microphone inputs and a switch to key the transmitters on. The case, battery holder, and switches came from Radio

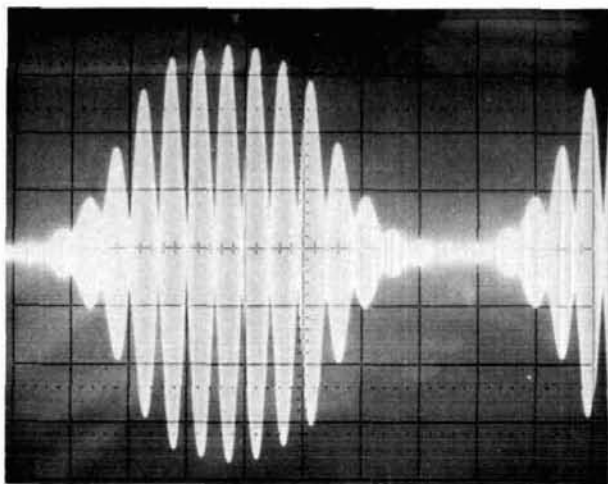


fig. 7. Pseudo voice pattern using "Modulated" functions.

Shack. Mylar capacitors should be used in the filter sections and the phase shift network. The 0.1  $\mu$ F capacitor shown in the power supply line should be placed directly across pin 16 and 8 of U1.

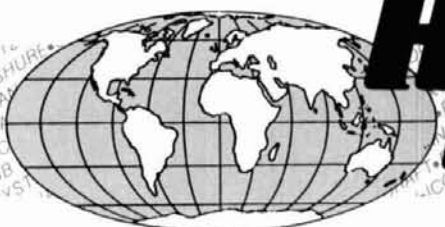
### alternatives

One alternative that might be tried is using a 32 kHz watch crystal. In this case, R1 should be changed to 10 Megohms and R2 to 680 or 750K. Only four stages of binary division would be required to produce 4096 Hz at the input of U2A, resulting in input tones of 2048 Hz and 682.66 Hz. The TL084 and LM353 ICs were used because they produce very little distortion. An LM324 and an LM348 could be used if resistors were added from the output of each amp to either ground or  $V_{cc}$  to cause the IC to always supply current in one direction. The crossover glitch is very visible on a sine wave. Don't omit the load resistors on the transformers; if you do, significant distortion will result.



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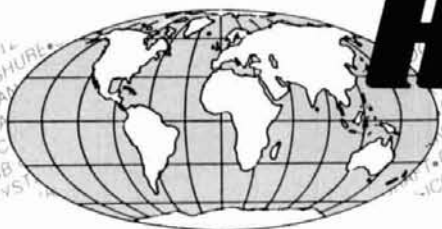


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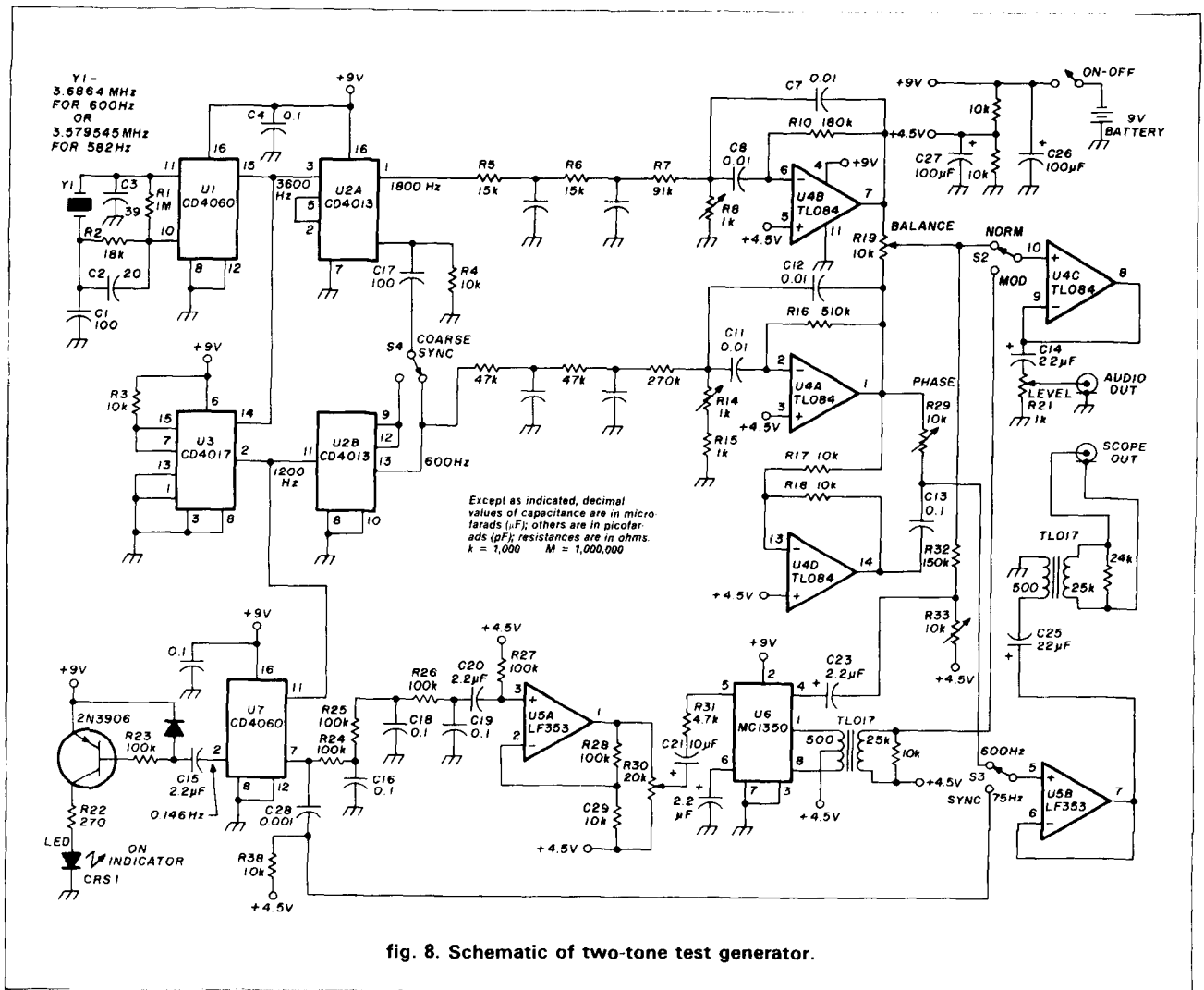
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If you want to operate the two-tone test generator from an external AC or DC supply, or to ground the case to some external test equipment, an isolation transformer must be added to the audio output. In this case, T1 would not be needed, and the scope could be driven directly from voltage follower U5B. I tried this in one case and it worked fine. Again, don't forget to terminate the transformer correctly! The power supply can be anything from 8 to 14 volts but must have very low ripple. I would recommend a three-terminal regulator in this case.

### testing the circuit

Plug in the digital ICs. Use some form of current limiting in the power supply — to begin with, a 10-ohm resistor in series with a battery or a current limiting power supply. Turn the unit on and determine that normal current is flowing. Check for 3600 Hz, 1800 Hz, 1200 Hz, 600 Hz, 75 Hz, and 0.146 Hz at the places shown. If the lamp begins to flash every 5 seconds or so, then you can be sure most of it is working.

Plug in U4 and U5. Place a scope probe at the output of the 1800 Hz sine wave generator, U4B, and adjust R8 for maximum. Approximately 2 volts peak-to-peak should be present at this point. If the level is too high, causing distortion, and everything else checks out, increase the values of R5 and R6. In the same way, check out the 600 Hz sine wave generator. Move the scope to the output connector. Look for about 2 volts peak-to-peak of combined 600 Hz and 1800 Hz as the balance control is varied (with level at maximum) and for normal operation of the level control. Check at the output of U5A for a 75 Hz sine wave.

Put the scope on the output again, adjusting for 1800 Hz only. Put the S2 in the "mod" position and adjust R33 and R30 to produce approximately 100 percent modulation of the 1800 Hz tone with a peak level equal to the level in the "normal" position. Some interaction is present between these two controls, so several adjustments may be necessary. Turn the balance control for only a 600 Hz tone and check for approximately the same peak voltage in the "mod"

and "normal" positions. The only glitch I've noticed in building several units is a tendency to oscillate when the level control is set at maximum. This occurred on a unit that used ribbon cable to connect the controls to the PC board, and since the level control is rarely at maximum in operation, I decided to ignore it.

### conclusion

A two-tone generator with a "bow tie" pattern makes it easy to check linearity in an SSB transmitter. In fact, I found I had to be careful because I ended up trying to correct linearity problems that were normal to the equipment! But on the whole, it has made SSB servicing much easier and is certainly less expensive than a spectrum analyzer.

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Last month I discussed methods for isolating the dead stage in a radio receiver. These methods — signal injection and signal tracing — are capable of showing us which stage is bad, and from there we can do further troubleshooting to isolate the faulty component.

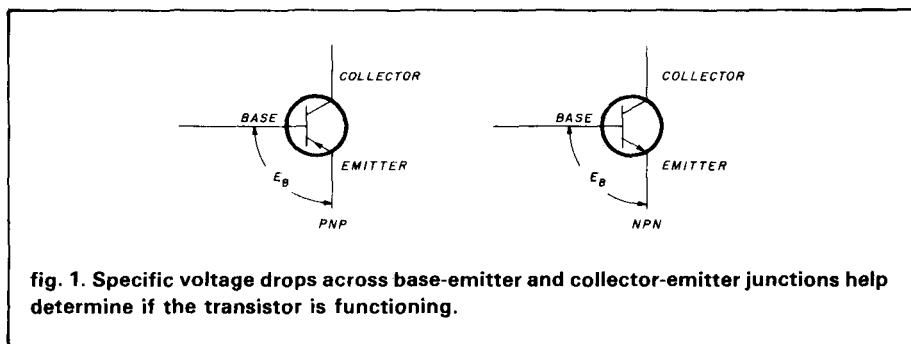
In this installment, we'll look at another method that I learned more than two decades ago when solid-state car radios first appeared on the market. This method uses a DC voltmeter to isolate the faulty stage. It's not fool-proof, but is well suited to many applications — especially when combined with other methods.

First, let's look at **fig. 1**. Here we have NPN and PNP transistors. In most amplifier circuits the base-emitter voltage will be 0.2 to 0.3 volts for normal germanium transistors (used in older equipment) and 0.6 to 0.7 volts for silicon transistors. In a PNP transistor the base is more negative than the emitter, and in an NPN transistor the base is more positive than the emitter.

Further, the collector will be more positive than either base or emitter in NPN transistors,\* and more negative in PNP transistors. Keep in mind that the term "more negative" can mean "less positive" in some cases. I know that's confusing, so let's try to clean

it up. Consider **fig. 2**. Here we have a cascade chain of three stages in a radio receiver. Each stage consists of a PNP transistor that's powered from

can often be located from the service manual, but in some cases you'll have to fake it. Look for the electrolytic "filter capacitor" used to decouple the



a positive DC power supply. The collectors of the transistors are near ground potential, while the emitters and bases are closer to the +10.5 volt "B+" line. If you measure the collector voltage with respect to ground, you'll find it very slightly positive, while the emitters are at a much higher potential. Thus, the collector's being less positive "causes it to perform as if it were negative."

Voltmeter "A" will measure the potential between the points being measured (in **fig. 1**, an emitter) and ground. If the voltage is near normal at each stage, then we can assume that there are no massive short circuits — but we can't get a hint of whether the stage is working properly.

Voltmeter "B" is connected with its positive electrode on the B+ distribution line, and the other used to probe the emitters of the stages. The B+ line

B+ line (C1 in **fig. 2**). This filter capacitor will denote the proper line (unless you accidentally selected C2!), and usually has enough of a tab to allow connection of the voltmeter probe.

The voltage drop across the emitter resistor of each stage indicates the current conduction of the stage. If the service manual does not give the normal voltage drop, then calculate it from the emitter potential printed on the schematic and the B+ voltage. In the case of the IF amplifier of **fig. 2**, for example, the emitter voltage is 9.1 volts, while the B+ voltage is 10.5 volts. The normal conduction of this stage will be indicated by a voltage drop across the resistor of 10.5 - 9.1, or 1.4 volts. Any radical departure from this value indicates a problem. For example, a shorted transistor would send that conduction voltage (across R3) up to near 10 volts, while

\*If the transistor stage is in saturation, the collector voltage will drop below the base voltage — i.e.,  $V_{CE_{SAT}}$  and  $V_{BE_{SAT}}$

a leaky transistor would place the voltage somewhat lower but still larger than 1.4 volts. Similarly, an open emitter (or other condition that cuts off the stage) will reduce the voltage across the emitter resistor to nearly zero.

We can isolate the defective stage by looking at each emitter voltage in turn. Most often, the defective stage will show up from an anomaly in the emitter conduction voltages.

Radios with NPN transistors in the stages are similarly treated. **Figure 3** shows a radio with NPN transistors powered by a positive-to-ground DC power supply. The collectors of these transistors will be close to the B+ potential, while the emitter and base voltages will be a lot lower. The values shown in **fig. 3** are typical, but they are not to be held as absolute (there are a lot of design choices that could alter the values, so buy and consult the service manual for your rig).

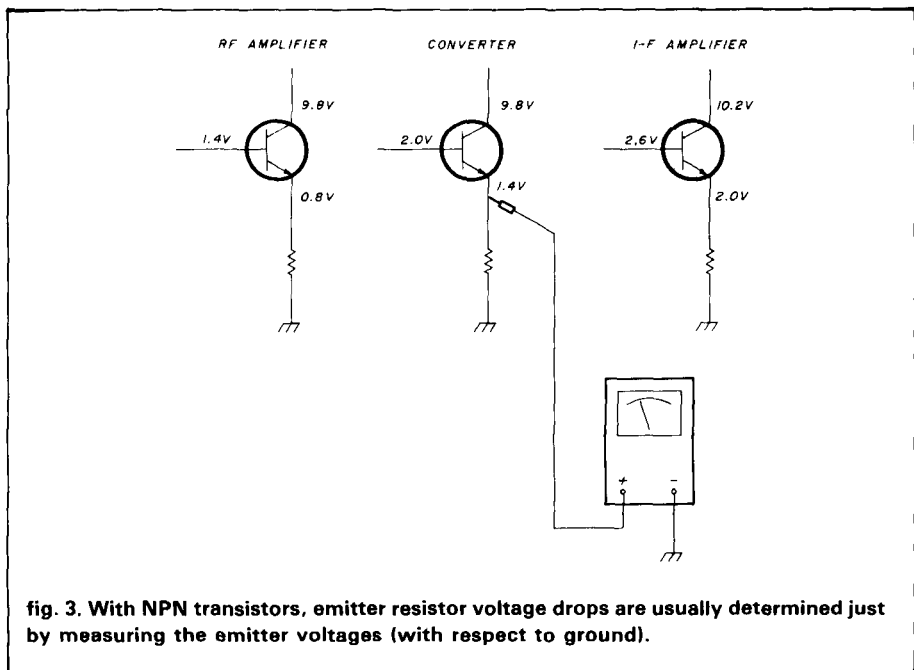
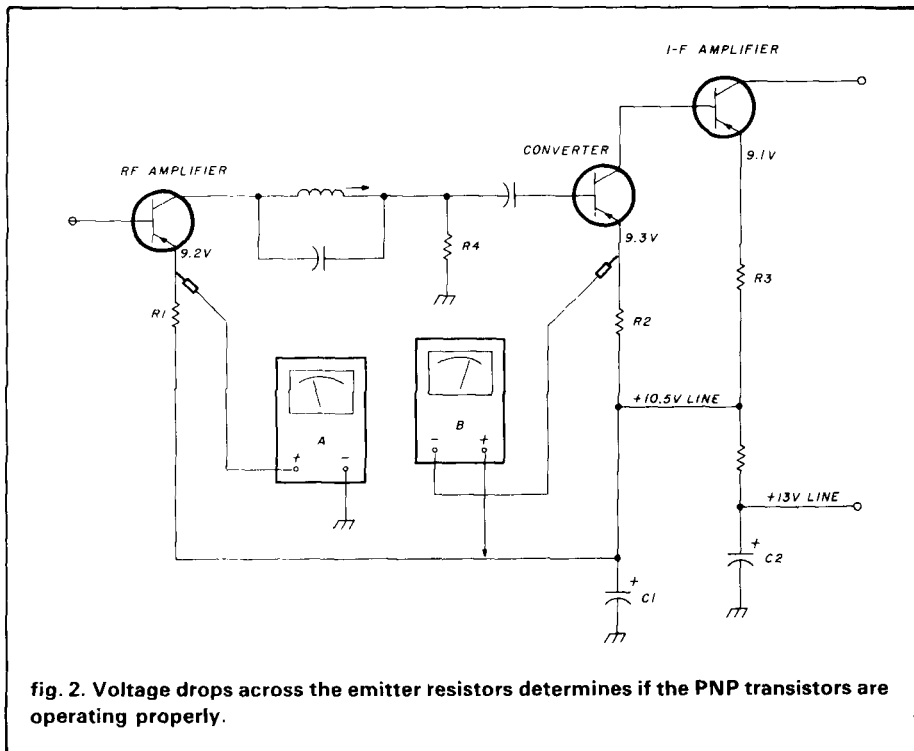
As in the case of the PNP stages, the NPN emitter conduction voltage denotes stage activity. In this type of circuit, however, the reference is ground instead of the B+ line. The principle is the same, however. We can check each conduction voltage in its turn and determine whether any of them are off. Fortunately, there are fewer calculations to make in this type of circuit. The emitter voltage on the schematic is the conduction voltage.

Both of the methods discussed above assume that there is a positive with respect to ground DC power supply. This arrangement is used in all modern American automobiles, so will be found typically in mobile rigs. In home rigs the DC power supply is often the same positive with respect to ground as shown here, but that is not necessarily so. It might be the case that the power supply is negative with respect to ground, or that there are two power supplies (one positive to ground and one negative to ground). The principle in these cases are the same, only the point of voltage reference will change.

Variable frequency oscillators,

whether in a receiver or transmitter VFO, will behave a little differently. In most cases, the DC conduction of the oscillator transistor varies with frequency setting. Typically, the voltage

will be higher at the low end of the band, and lower on the high end of the band (with a smooth transition as the dial is tuned). A sudden discontinuity in this transition might indicate a sud-



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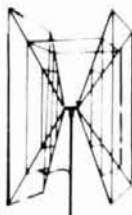
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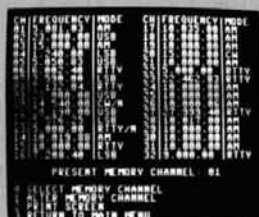
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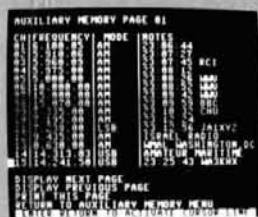
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den cessation of oscillation (or a parasitic developing) at that point on the dial.

Crystal oscillators behave in a similar manner. If the crystal selector switch is changed, then the voltage can be expected to change also. If the crystal is removed, then the voltage will usually change radically.

By the way, don't remove crystals willy-nilly. In some cases, especially when the next stage is a grid-leak biased vacuum tube power amplifier, damage might occur to the equipment.

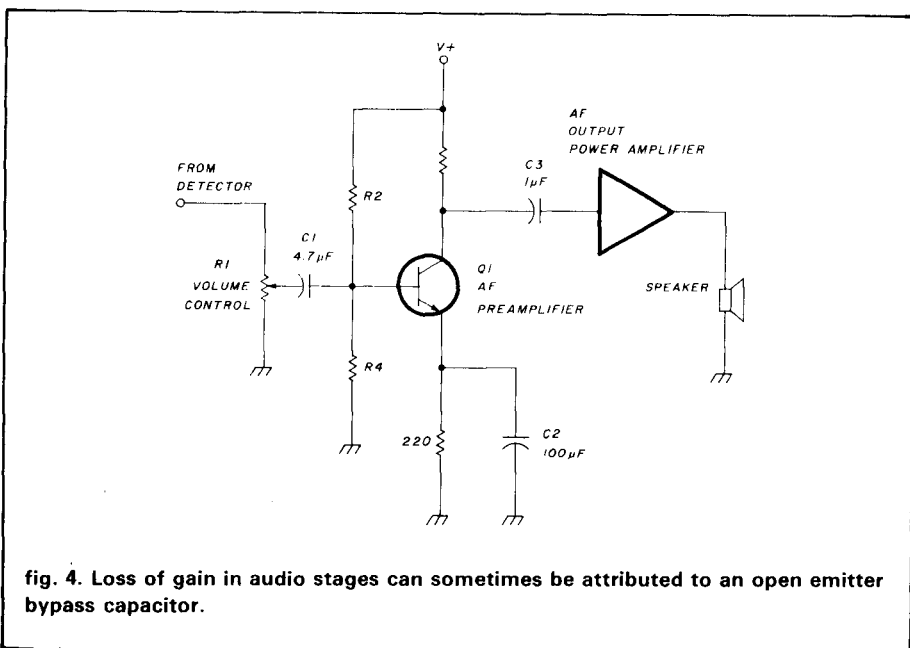
### an ambiguous case

There are three ways to stage isolate a dead radio receiver. In part I of this two-part series, we reviewed signal injection and signal tracing and in this article we discuss using a DC voltmeter to find the defective solid-state stage. But some situations are not as clear.

Consider **fig. 4**. This circuit is a simplified audio section, with only the preamplifier shown in detail. The combination of AF preamplifier and output power amplifier may be capacitor coupled (as shown here), direct coupled or in the form of a single integrated circuit housing both stages. The symptom is weak reception. All stations are heard, but at very low volume. If you read last month's article, you'll recall that this symptom generally points to the output IF amplifier, detector or audio stages; but in this case, it's the audio stage that contains the fault.

I've seen a lot of cases where the DC voltages on Q1 were normal and there seemed to be adequate signal passing through the stage regardless of whether signal injection or tracing was used. The ambiguity will show up except in the very special case where the sensitivities and impedances of the signal generator and signal tracer are matched to the particular equipment being serviced (some "radio analyst" instruments used by commercial servicers fall into this category).

In the event that this ambiguity



**fig. 4.** Loss of gain in audio stages can sometimes be attributed to an open emitter bypass capacitor.

shows up, jump on capacitor C2. This capacitor is used to place the emitter of Q2 at or near ground potential for AC while retaining the DC bias on the emitter. If this capacitor opens up, the gain of the stage will go down one heckuva lot without (usually) affecting the DC voltages. Turn the rig off, solder tack a replacement capacitor across C2 (the exact value isn't critical — anything  $\pm 200$  percent of the correct value will do for the test). Turn the rig on. If the output volume comes up a lot, then mark C2 for replacement.

I don't know why it is, but this problem seems to keep popping up. I've seen it in varying degrees in car radios, home radios, Amateur radios, CB radios and commercial two-way radios. It also turns up in vacuum tube equipment.

*Old Gear Restorer's Note:* If you restore an old Heath DX-60B (or other older transmitter) and find the RF output intermittent as the rig is keyed, then look to the plate circuit of the crystal oscillator. This circuit is a modified Miller oscillator, and has a slug-adjusted inductor in the plate circuit. When the rig is stored, unused for several years, the core of this coil will

change characteristics, and the oscillator will refuse to oscillate reliably. I scratched my head over two of these rigs last year and finally stumbled on the answer. While keying the rig, carefully adjust the slug until reliable operation occurs (as indicated by a light-bulb dummy load or RF wattmeter), then give it another turn or so.

Incidentally, similar circuits are used in a lot of older ham gear, both vacuum tube and solid state, HF and VHF. Anytime you have a piece of equipment with an oscillator of this type that seems to operate intermittently or unreliably, and everything else seems to check out, then consider adjusting the coil.

Normally I don't recommend "diddlestick" troubleshooting — to the extent of hollering "NEVER!" when someone suggests it. One of the few possible exceptions might be in equipment that has been unused for many years, and contains ferrite core coils in oscillator circuits. I still maintain that sudden failures in equipment that has been working should be regarded as a component failure, not as an alignment problem so in that case, leave the darned diddlestick in the toolbox!

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# the offset drooper

## an improved ground plane

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The original "ground plane" omnidirectional antenna was developed in the late 1930s jointly by Dr. George H. Brown, J. Epstein and R. F. Lewis, W2EBS, all of RCA Laboratories. It consists of the long-familiar configuration of a vertical quarter wave "spike" working against four resonant radials at 90 degrees to the mast. In the original version, patented in 1941, the feedpoint impedance is matched to the coaxial feedline by means of a quarter wave coaxial "Q" section. A typical Amateur adaptation is shown in **fig. 1**. In 1942 Dr. Brown patented, solely, the version shown in **fig. 2**, which has several advantages over that of **fig. 1**.

These basic "ground plane" antennas exhibited less antenna effect (surface current) on the mast and feedline than did other omnidirectional VHF antennas widely used at the time. However, the four radials at 90 degrees to the mast are somewhat "transparent" and definitely resonant. For this reason they may be considered more a part of the antenna than a virtual ground plane for the "spike." Semi-infinite ground plane characteristics would allow little radiation below zero degrees elevation. Such a pattern might be unsuited to a mountain top location or a swaying free-standing mast.

Because of the direction of current flow in the radials, the resultant radiation from the individual spikes results in good cancellation, and there is little net radiation from them. The fact that one may touch the tip of one radial with little effect on VSWR doesn't mean that the radials do a good job of simulating a large, flat conductive sheet. Because of the quarter wavelength of the radials, pinching the tip of one elevates the impedance at the opposite end and effectively isolates it. The remaining three radials simply take over, with only moderate detuning of the antenna.

The result of all this is as follows: the performance of a "90 degree" ground plane represents an improvement over several previously popular base station antennas. However, while orienting the resonant radials at 90 degrees does reduce inductive coupling to the coaxial line and mast, it doesn't effectively eliminate it. The coupling is sufficient that the resulting antenna effect may be found undesirable for some applications.

Long popular among hams for VHF and upper HF is the "droopong" ground plane, a simplified, less elegant, low-cost descendant of the Brown ground plane. Simply bending down the horizontal radials to about 45 degrees raises the radiation resistance to 50-52 ohms. This permits direct connection of the coax without use of a matching device. A more appropriate description might be "skeleton skirt dipole," because the resonant drooping radials don't do a very good job of serving as a virtual ground plane. Instead, they exhibit more inductive coupling to the feedline than do radials at 90 degrees.

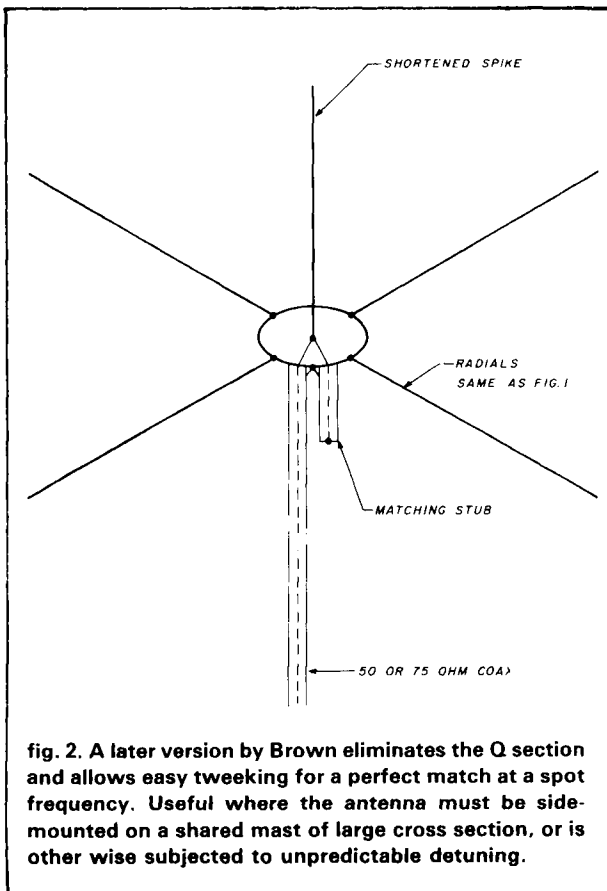
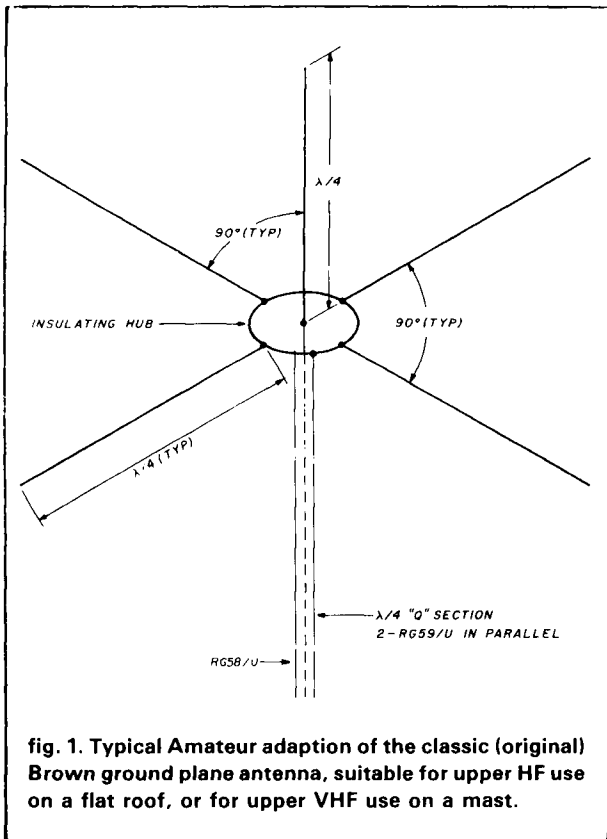
Nearly 40 years ago, in the *Antenna Manual*, I pointed out that while the drooping ground plane or "drooper" is simple and works well, the configuration aggravates antenna effect. For the benefit of those not familiar with the term, *antenna effect* (transmit case) can be described briefly as follows:

*Antenna effect on a two-wire line:* refers to line radiation as a result of "common mode" current. Part of the power (energy) fed to the feedline travels on it as though the two wires were tied together and were working against ground. Usually it results from load imbalance and/or excessive coupling from one side of a balanced antenna to the line. Common mode current adds in one wire and subtracts in the other. This in-phase component of the total power fed to the line acts as though the two wires were in parallel. So it gets radiated.

*Antenna effect on a coaxial line* refers to radiation from a coaxial feedline as a result of current flowing on the outside of the outer conductor. The current often is shared with the surface of a metal mast supporting a bottom-fed vertical antenna. Usually it results from either or both of the following:

- The outer conductor of the coax is directly connected to a point on the antenna not precisely at

By Woodrow Smith, W6BCX, P.O. Box 2898,  
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ground potential. As a result, current flows not just to the antenna, but is encouraged to flow back down the *outside* of the coax shield to a virtual ground as well. The "ground" can be a cabinet at VHF or house wiring at HF, for example.

- Excess inductive coupling exists from one half of the antenna to the outside of the coax or metal supporting mast (or both). The radials of a drooping ground plane are a case in point. If the coax is enclosed by a metal mast, spurious current flows on the surface of the mast. If the coax is draped along the outside of a metal mast, current flows on the surfaces of both and *both* radiate. To complicate things, the mast can have its own virtual ground.

### is antenna effect all that devastating?

At just what point antenna effect becomes serious enough to be concerned about is debatable. The amount of current that can be tolerated on the outside of a coax line or mast or both depends to a great extent upon the following:

On transmit, let's first consider a well elevated, vertically polarized, omnidirectional VHF antenna with a feedline many wavelengths long. What is the result of antenna effect? Normally little of the power (energy) radiated with vertical polarization from such a long feedline (and the mast) will be directed at the horizon. For this reason, little of the spurious radiation will either add to or subtract from the energy being radiated effectively towards the horizon by the antenna proper.

So at VHF the end result of antenna effect on *transmit* is primarily a waste of power. But even if as much as 20 percent of the total radiated power is radiated by the coax, mast or both and thereby wasted, the resulting 1 dB loss is hardly anything to get worked up about. This is especially true when it buys worthwhile simplicity, convenience, or economy. However, if the radiating coax passes close to a TV receiver feedline, TVI may result if the TV coax suffers from poor shielding, or if the TV twinlead feeds a poorly balanced receiver front end.

On *receive*, the situation is different. Consider a coax line running through a localized area of high ambient noise. Antenna effect can cause noise picked up by the outer conductor of the coax to travel up to the antenna proper, then back down the coax to the receiver input just like a desired signal.

### baluns vs. resonant isolators

Baluns of the type used with HF dipoles to minimize antenna effect are not suited for use with vertically polarized VHF antennas of the omnidirectional type. Instead, resonant detuning sleeves, cones, and radials are widely used as isolators or decouplers to "cool off" the mast and feedline. To what extent these produce any practical benefit in a particular installation by



reducing antenna effect often is open to question. The use of coiled coax, ferrite beads, or a ferrite sleeve to choke off or dissipate surface current on the coax does not solve the metal mast problem.

Granted, no startling increase in transmitted signal strength will be noted when a resonant isolator of some kind is added to a simple VHF drooping ground plane. But even so, suppose it were possible to achieve a big reduction in antenna effect on the drooper without adding a resonant isolator. Suppose the various resulting advantages (such as they are) could be achieved by simply altering the dimensions and the droop angle.

### **something for nothing?**

It's not only possible; it's *simple*. And there are no additional parts or materials, and without any additional manufacturing, construction, or assembly labor. Here's how: take the case of a conventional drooper that's supported by a metal mast enclosing the coax. Current is induced on the mast as a result of inductive (mutual impedance) coupling to the radials. If the coax exits the hub external to the mast (offset antenna mount), spurious current also appears on the outside of the coax.

This detrimental inductive coupling can be reduced somewhat by reducing the droop of the radials (the angle they make with the horizontal). The remainder can be compensated for by deliberately introducing a critical amount of conductive coupling of opposite phase. This is done by drastically offsetting the feedpoint from the voltage node.

The offset required for good cancellation is accomplished by simply making the radials as much as 30 percent (yes, thirty percent!) longer than the spike. Because precise cancellation is somewhat frequency-sensitive, the effectiveness will vary a bit over the 2-meter band. However, in spite of the fact that optimized coupling neutralization is less than perfect over the whole band, the practical results obtained are most worthwhile.

Offsetting the feedpoint from the voltage node raises the feedpoint resistance. On the other hand, lessening the droop angle lowers the feedpoint resistance (by lowering the radiation resistance). By proper choice of these two values, it's possible to reduce antenna effect dramatically while at the same time achieving a 50-ohm feedpoint resistance. With an offset represented by a 28-30 percent radial-to-spike length differential, a 27-29 degree droop angle provides both maximum reduction in antenna effect *and* a 50-ohm feedpoint resistance. To some extent the optimum values vary with conductor diameter, mast diameter, and hub geometry. Less important is whether the coax departs the hub inside or outside the tubular mast.

Neither the 1.5 VSWR bandwidth nor the antenna gain is noticeably degraded by drastically offsetting the feedpoint and reducing the droop of the radials. And in case you're skeptical about the horizon gain comparisons, it's true that the spike is slightly shorter on an offset drooper. Likewise, the resultant vertical component or vector of the drooping radials is a little shorter for an offset drooper than for a regular drooper. But careful measurements show this does not affect the gain significantly. Increased current throughout the antenna resulting from the lower radiation resistance (about 35 ohms) compensates. Also, power wasted by line and mast radiation is reduced to insignificance.

Out of curiosity, a check was made to see just what would happen if the feedpoint of a classic 90-degree ground plane were deliberately offset. When the resonant radials were lengthened, an arbitrary 12 percent and the spike length and matching adjustment were re-optimized, antenna effect was virtually eliminated. However, overall performance was no better than that of an offset drooper, which has the advantage of requiring no matching device. Because of the latter, no further work was done with 90 degree ground planes. It is interesting to note that when resonant radials at 90 degrees to the mast were shortened experimentally by no more than a few percent, antenna effect was markedly aggravated.

### **improvement over what?**

A check was made on drooper dimensions given in various handbooks and past magazine articles. Also, two different commercially manufactured 2-meter droopers were purchased and the dimensions measured. The effective radial length ranged from slightly longer than the spike to slightly shorter. All were series-fed at the hub without benefit of a matching device. None employed a resonant decoupler, such as an extra set of radials below the antenna oriented 90 degrees to the mast.

The reduction of antenna effect provided by drastically offsetting the feedpoint of a drooping ground plane depends, among other things, upon how bad the antenna effect is to begin with. This varies somewhat with location of the voltage node on the regular drooper used for comparison. For instance, antenna effect definitely will be worse if the radials of a regular drooper are significantly shorter than the spike, as was the case with one of the name brand antennas tested. This makes an offset drooper appear just that much better by comparison.

### **a spurious top-fed Marconi is the culprit**

The degree of improvement will also vary with the length of the coax. This is explained as follows: the



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outside of the coax shield will do its best to act like a "harmonic Marconi" fed at the top instead of the bottom. Just how effective (and therefore how objectionable) this is will depend to a great extent upon the electrical length of the coax shield in wavelengths from "virtual ground" to the point of attachment to the radials.

Unfortunately, with 40 feet of coax, QSY from 144 to 148 MHz can change the electrical length of the shield substantially. This in turn affects the feedpoint impedance of the spurious "upside down harmonic Marconi." The variation can affect the amount of line radiation by 10 dB or more in the case of a conventional drooper. Things get even more involved when comparing an offset drooper to a regular drooper for antenna effect simply by swapping them at the end of the same feedline. The radials of a 2-meter offset drooper are longer than a quarter wave and their impedance to ground at their feedpoint therefore is affected. This was taken into account when designing the antenna and making comparison measurements.

### the test set-up

For reference, a 2-meter drooper with optimized offset feed was constructed with four radials 30 percent longer than the spike and having a droop angle of 28 degrees. For starters for those who might like to experiment, the 1/8 inch diameter spike measured 18 3/8 inches and the 3/32 inch diameter radials 24 inches, all of brass welding rod. Size and configuration of the hub will affect the lengths, especially that of the spike. Note that while the spike of an offset drooper is only slightly shorter than normal, the radials are much longer. The result is that the overall length of the spike plus a radial is nearly 10 percent longer than for a conventional drooper. This involves the integral coupling neutralization and impedance transformation process, and a rigorous explanation is not within the scope of this article.

The offset drooper reference antenna just described was compared to four different conventional 2-meter droopers for antenna effect, 1.5:1 VSWR bandwidth, and field strength at zero elevation angle. One of the conventional droopers was constructed to dimensions specified in a magazine article. Two were dissimilar name brand units. None employed a detuning sleeve, cone, or extra set of radials. Measurements were taken near 144, 146, and 148 MHz with four feedline lengths differing by 1/8 wavelength.

Tests were first run with the coax leaving the hub contained within a 3/4 inch O.D. mast for the first 5 feet. The tests then were repeated with the hubs offset from the top of the 5 foot upper mast section. With the hubs offset, the coax was brought down snugly against the outside of the mast for its entire length.

Next, the hub was mounted concentrically atop a 12-foot section of aluminum tubing strapped to a steel vent pipe, with the coax brought down inside the tubing. While these changes did cause the readings to change, the overall improvement exhibited by the offset drooper did not change significantly. The coax employed was RG/8X-8M 0.25 inches OD, 52 ohm.

### test results

A spurious RF current sniffer was improvised to quantify the amount of improvement exhibited by the offset drooper. The sniffer was provided with a plastic spacing fixture that allowed choice of two spacings in order to increase the useful range. It was checked for directional effect (by reversing it) and the directivity was found to be negligible. Relative calibration in dB was accomplished by simply varying the measured power fed to a leaky dummy load which was space-coupled to the sniffer.

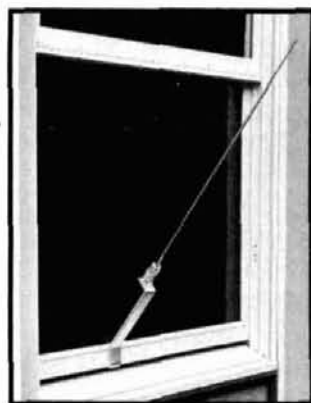
The reduction in antenna effect when using the offset drooper exceeded 11 dB for three of the comparison antennas tested. The improvement obtained over the fourth regular drooper (the one with the longest radials) measured 10 dB. The greatest improvement was observed when the offset drooper was compared to the regular drooper having the shortest radials (about 5 percent shorter than the spike). The improvement figures reflect those obtained or exceeded with the worst case combination of frequency, line length, and mast and feedline configuration.

This article is not intended to show the reader how to build something exactly like the author's, but instead to explain a simple method of improving the performance of the venerable drooping ground plane. Just make the spike a little shorter, the radials a lot longer and bend the radials up a bit. It is applicable to modification of existing antennas as well as to new construction. To approach the maximum possible improvement, all you need is a VSWR meter. Just make the radials 30 percent longer than the spike and droop them 28 degrees (or as close as you can). Optimum length for the spike is usually about 6 percent shorter than for a regular drooper that uses similar hub and element diameter.

If this doesn't result in equal VSWR at the band edges, the spike is too long or too short. Once the radial length and droop are optimized, the center frequency can be fudged about 1 percent just by trimming the spike.

The reader will notice that no VSWR numbers are given for an optimum offset drooper. The reason for this is that a conventional drooper with bad antenna effect can give specious VSWR readings, making any offset drooper comparisons meaningless. The deceptive readings obtained with a standard drooper will change with coax and mast lengths, and the readings

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can be considerably better (or worse) than the true antenna VSWR. To a lesser extent this applies also to a classic 90 degree ground plane. But with an optimized offset drooper, readings will change little with line and mast lengths (except as reduced by line attenuation), and can be relied upon. The true VSWR of a properly optimized 2-meter offset drooper will approach 1.0:1 over much of the band, and be found very low at the band edges.

## so why not?

In closing, I hope the reader accepts the fact that while a bad case of antenna effect on a VHF drooper isn't necessarily disastrous, minimizing it certainly can't hurt. It's easy to do and all it can do is good — so why not?

## references

1. *Ground Plane Antenna*, U.S. Patent 2,234,333, issued March 11, 1941, to G.H. Brown, J. Epstein, and R.F. Lewis of RCA Laboratories.
2. *Improved Ground Plane Antenna*, U.S. Patent 2,275,342, issued March 3, 1942, to G.H. Brown.
3. Woodrow Smith, *The Antenna Manual*, Editors and Engineers, Ltd, Santa Barbara, California, 1948.

## bibliography

Vance, Harold C., Sr., K2FF, "The Ground Plane Antenna: Its History and Development," *ham radio*, January 1977, page 26.

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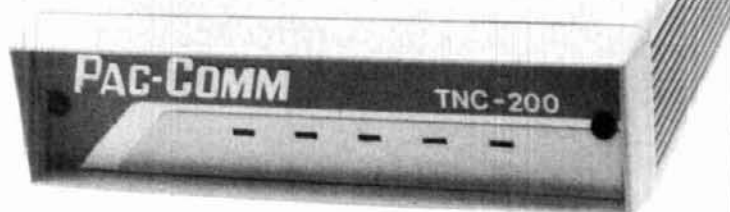
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## reflector antennas: part 1

The subject of reflector antennas in general and those of the parabolic dish type in particular generates lots of correspondence and requests for information. I never knew that any single VHF/UHF/SHF antenna could be so much on everyone's mind — especially since so much material has already been written on the subject. Confusion seems to reign.

Since it began, this column has concentrated on providing solid groundwork in the lower frequencies; limits of time and space have not allowed discussion of more narrowly-defined topics such as specific types of antennas. But with last month's column, we launched a discussion of the microwave bands<sup>1</sup> so this would seem to be an appropriate time to address the subject of reflector antennas since they're so often used at UHF and microwave frequencies.

This discussion will be divided into two parts. Part I — this month's column — addresses the electrical aspects of reflector antenna design, including gain and specific parameters of the parabolic antenna. Part II — next month's column — will cover feed systems and the mechanical aspects of parabolic antenna design. With Parts I and II in hand, you should have all the required material and references necessary to design and build a first-class parabolic antenna.

## reflector antenna types

Before discussing the parabolic dish, it should be interesting to review some of the more common types of reflector antennas. They include, but are not limited to, the cylindrical parabola, parabolic dish, corner reflector, backfire, spherical dish, and dual reflector types of antennas.

The *cylindrical parabola* (fig. 1A), believed to be the first RF-type of reflector antenna, was used by Heinrich Hertz in 1888! He illuminated a reflector with a spark-gap at about 66 cm (445 MHz) in an attempt to prove the existence of electromagnetic waves, which had been theoretically predicted by James Clerk Maxwell.<sup>2</sup> For best performance, the cylindrical parabola requires a line feed. (Thus was born the field of microwave optics.) An Amateur cylindrical parabola is described in reference 3.

Reflector antennas were soon eclipsed by the search for DX on the HF (high frequency) bands by Marconi and others. Thus it wasn't until the 1930s that serious work on reflector antennas got under way, primarily through the efforts of Grote Reber, ex W9GFZ, in his radioastronomy experiments. Reber used the parabolic dish type of antenna shown in fig. 1B. Properly designed, it focuses all the energy at a common point, which greatly simplifies the feed system. Hence it is often referred to as a prime focus-fed antenna.

The *corner reflector*, as depicted in fig. 1C, was invented by Dr. John

Kraus, W8JK, in 1940.<sup>4</sup> However, it is limited to gains of up to about 15 to 20 dBi and is quite large relative to the gain delivered.

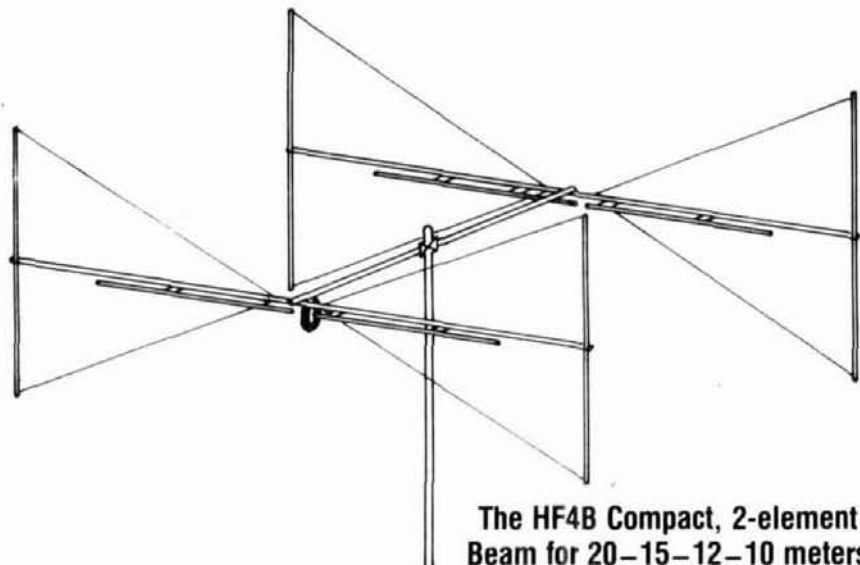
The *backfire antenna* was invented by Dr. Herman Ehrenspeck in 1958.<sup>5</sup> He discovered that if a Yagi antenna were aimed into a special reflector system and the Yagi structure properly re-tuned, its gain could be increased by 3 to 5 dB (fig. 1D). However, the backfire antenna never gained popularity because it required a large reflector with a special stepped surface.

Later Dr. Ehrenspeck designed the *short backfire antenna* shown in fig. 1E.<sup>6</sup> It's smaller and simpler, but its gain is lower (16 dBi is typical). However, it has gained popularity with the military, especially for portable VHF/UHF satellite operation.

At first glance, the *spherical reflector* looks very much like a parabolic dish. But it has a different reflector profile and is very difficult to feed because the energy is not focused on a common point, as in the parabolic dish. Instead, the energy is present along a line, and a special phased line-source feed is required to properly phase the energy.

Because of its shape, the spherical reflector beam can be partially aimed by simply moving the feed system. This allows the beam to be steered off boresight by up to several times the antenna beamwidth, with little or no performance degradation. Hence the spherical reflector antenna is often used in large structures where the reflector is stationary.

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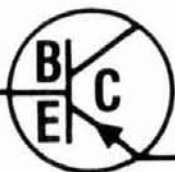


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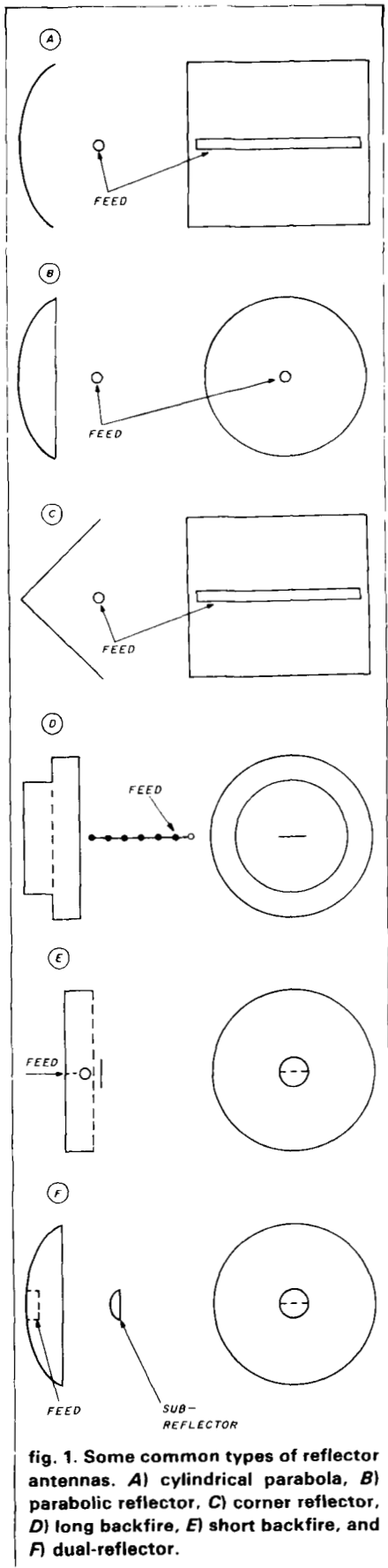
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Other antenna systems use a secondary reflector that allows the feed system to be placed at a more convenient point in the structure (see **fig. 1F**). Examples are the *Gregorian*, *Cassegrain*, and *Newtonian* feed-reflector antennas. There are many other variations of the antennas just described.<sup>2,7,8,9</sup> These variations are associated with the different feed system employed.

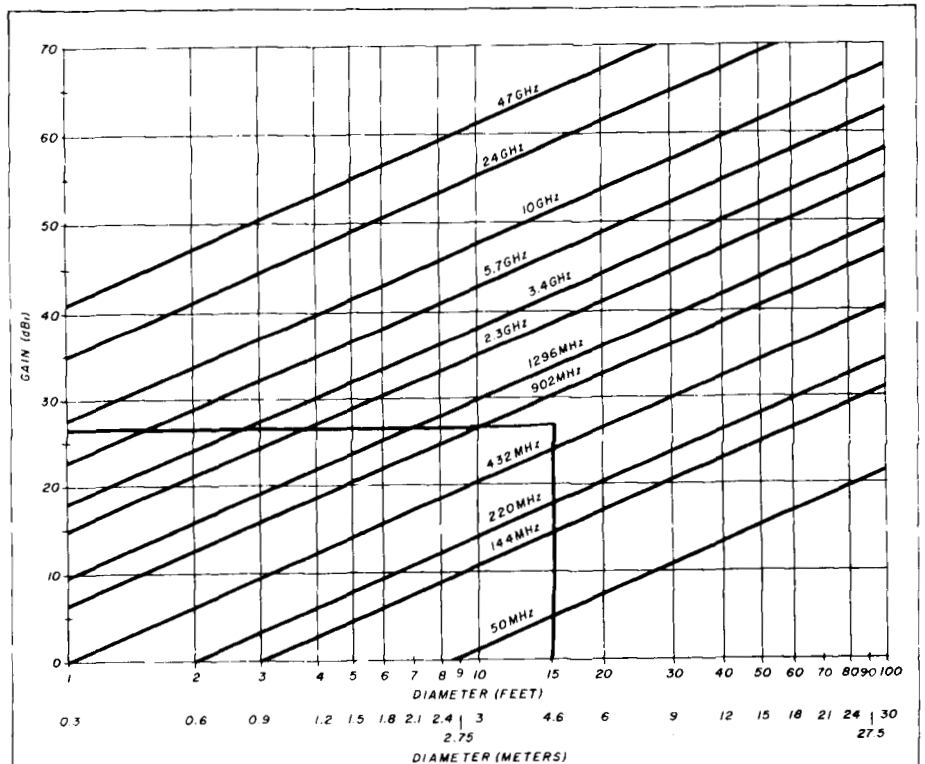
The implementation of a secondary type of reflector is usually beyond the reach of the typical Amateur and beyond the scope of this column. The improvement obtained with such systems is often at the expense of considerable complexity, which can often

be offset by designing a slightly larger antenna right from the start — certainly a typical Amateur approach!

### tradeoffs

All types of reflector antenna systems have their advantages and disadvantages. The technical literature on reflector antennas could easily fill a good-sized room! (See references 2, 7, 8, and 9 for starters.) But for the Amateur, the parabolic reflector antenna that uses a prime focus feed system as shown in **fig. 1B** is one of the simplest antennas for obtaining high performance with relatively straightforward construction.

Some of the main advantages of the parabolic dish include its use of a single feed; its ability to operate on other frequency bands by simply exchanging the feed system; its low noise pickup — i.e., its clean radiation pattern. It has reasonable gain for the size of the aperture employed. Its disadvantages include large surface area, which leaves it vulnerable to damage



**fig. 2. This graph is a plot of gain versus size for typical parabolic dishes with 55 percent efficiency.**

from wind or snow; comparatively large physical size (for gain) than a Yagi array offering equivalent gain; and the mechanics involved in designing the reflector and rotation system, especially if it's used on EME. Despite these shortcomings, the parabolic dish, with its single feed system, is a natural for the UHF and especially the Amateur microwave bands.

### gain and beamwidth

Generally speaking, the efficiency of a well-designed parabolic dish is in the range of 50 to 60 percent (more on this later). Hence it will have an effective aperture or capture area that is somewhat smaller than its physical area.<sup>10</sup>

Based on a 55-percent efficiency, a typical design standard, the gain of a well-constructed parabolic dish can be easily calculated using Eqn 1.

$$G = 10 \log [0.55 \cdot 4\pi A/2] \quad (1)$$

$$= 10 \log (6.9A/2)$$

where  $G$  is gain in dBi and  $A$  is the area of the reflector. Both area and wavelength must be in the same unit of measure.

For example, the area of a 20-foot (6.1-meter) diameter dish is about 314 square feet (29.2 square meters). At 432 MHz a wavelength is 2.277 feet (0.694 meters). Therefore, using Eqn 1, the gain would be about 26.2 dBi.

You may prefer to work directly in feet/meters and frequency. If so, the following formulas can be derived from Eqn 1.

$$G = -52.4 + 20 \log D + 20 \log F \quad (2)$$

where gain is in dBi,  $D$  is dish diameter in feet and  $F$  is frequency in MHz or

$$G = -42.1 + 20 \log D + 20 \log F \quad (3)$$

where  $G$  is in dBi,  $D$  is dish diameter in meters and  $F$  is in MHz. Eqns 2 and 3 yield the same gains as Eqn 1 without having to first calculate the reflector area.

In order to make it easier to rapidly determine gain, I have prepared the graph in fig. 2, which includes practical size reflectors and gains of 10 to 70

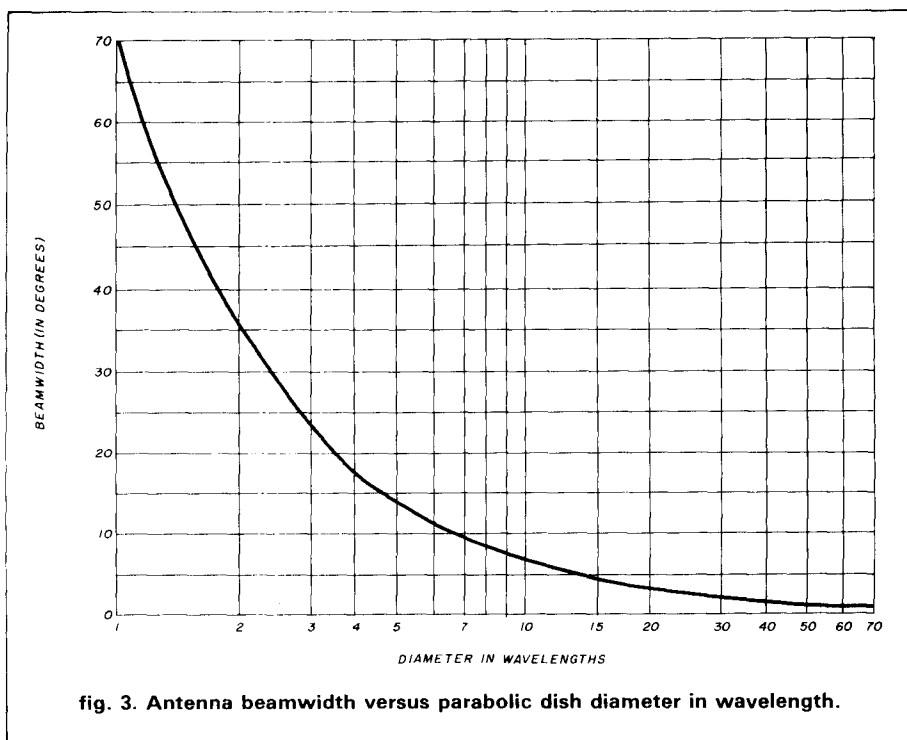


fig. 3. Antenna beamwidth versus parabolic dish diameter in wavelength.

table 1. Typical parabolic curve dimensions for a 20-foot (6.1 meter) diameter parabolic dish with a 0.5 f/d ratio.

distance from center of dish (Y)		depth of dish (X)	
feet	meters	inches	centimeters
1	0.305	0.3	0.76
2	0.61	1.2	3.05
3	0.915	2.7	6.86
4	1.22	4.8	12.19
5	1.52	7.5	19.05
6	1.83	10.8	27.43
7	2.13	14.7	37.34
8	2.44	19.2	48.77
9	2.74	24.3	61.72
10	3.05	30.0	76.2

dBi on most of the popular Amateur VHF/UHF bands. Note that in the example just described, the graph shows the gain to be about 26 dBi, very close to the calculated value!

Finally, it has been pointed out before in this column that as the gain of an antenna increases, the beamwidth decreases.<sup>11</sup> For a parabolic antenna, the beamwidth can easily be determined to a reasonable accuracy ( $\pm 10$  percent) using the following formula:

$$BW \approx 70\lambda/D \quad (4)$$

where  $BW$  is in degrees and  $D$  is the reflector diameter. Both wavelength and diameter must be in the same unit of measure.

For example, the antenna just described has a diameter of approximately 20 feet (6.1 meters). One wavelength at 432 MHz is approximately 2.28 feet (0.694 meters) and 0.76 feet (0.231 meters) at 1296 MHz. Hence its beamwidth would be approximately 8



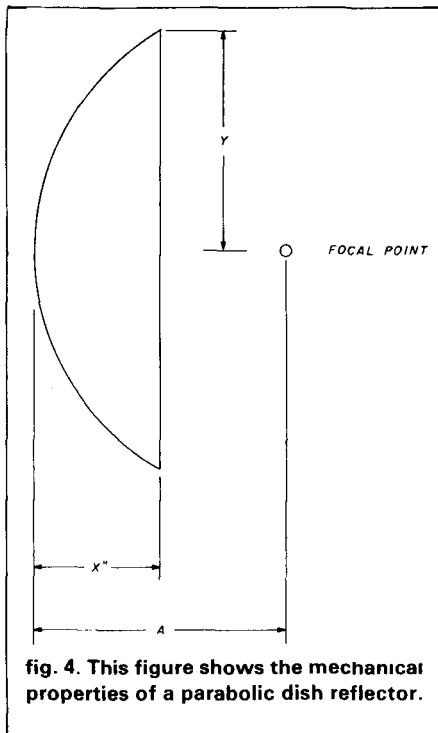


fig. 4. This figure shows the mechanical properties of a parabolic dish reflector.

degrees at 432 MHz and 2.66 degrees at 1296 MHz.

Properly designed, the parabolic dish has a symmetrical beamwidth the same in both E and H planes. The graph in fig. 3 has been prepared to simplify beamwidth estimation.

### design parameters

So how does one go about designing a parabolic dish? What tradeoffs are required? Where do you feed the dish?

First you have to understand the geometry of a parabolic dish. You must have a reflector that follows a parabolic curve. This is described mathematically by Eqn 5 below:

$$Y^2 = 4AX \quad (5)$$

where, referring to fig. 4,  $Y$  is the radius of the reflector,  $A$  is the focal length and  $X$  is the depth of the reflector, all in the same unit of measure.

If the diameter and focal point (as described below) are known, we can rearrange Eqn 5 to a more convenient form as shown below:

$$X = Y^2/4A \quad (6)$$

For instance, suppose that you want

to design a 20-foot (6.1 meter) diameter parabolic dish with a focal length of 10 feet (3.05 meters). Using Eqn 6, the edge of the dish will be 2.5 feet (65 cm) higher than the center of the dish. Likewise, a point halfway from the center will be 0.625 feet (19 cm) above the center, and so forth. Table 1 shows a typical parabolic curve for this example. With all the personal computers available, there are many kinds of programs to simplify the computation of a parabolic curve. References 12 and 13 will help you select such a program.

Finally, if the diameter and depth of the reflector are known, the focal point can be found by rearranging Eqn 5 as follows:

$$A = Y^2/4X \quad (7)$$

If you already have a dish, the focal point can easily be determined using Eqn 7. First measure the reflector diameter with a tape measure. The radius, or  $Y$ , is one-half the diameter. If a board or string is placed on the rim from one side of the reflector to the other, the depth,  $X$ , can be easily measured. For example, if we have a dish with a depth of 2.5 feet (0.762 meters) and a radius of 10 feet (3.048 meters), the focal point will be 10 feet (3.048 meters).

Next we must determine the  $f/d$  or focal length to diameter ratio using the following equation:

$$f/d = A/2Y \quad (8)$$

Using Eqn 8, the  $f/d$  ratio in the example above is 0.5 (10/20 feet or 3.05/6.1 meters). We now have all the mathematical parameters necessary to talk intelligently about the design of a parabolic dish type of antenna.

### parabolic dish characteristics

So why are the diameter, depth, focal point, and  $f/d$  ratio so important? It should be intuitive that the diameter of the reflector is the principal factor that determines the gain of a parabolic antenna. The larger the diameter, the higher the potential gain, as shown on the graph on fig. 2.

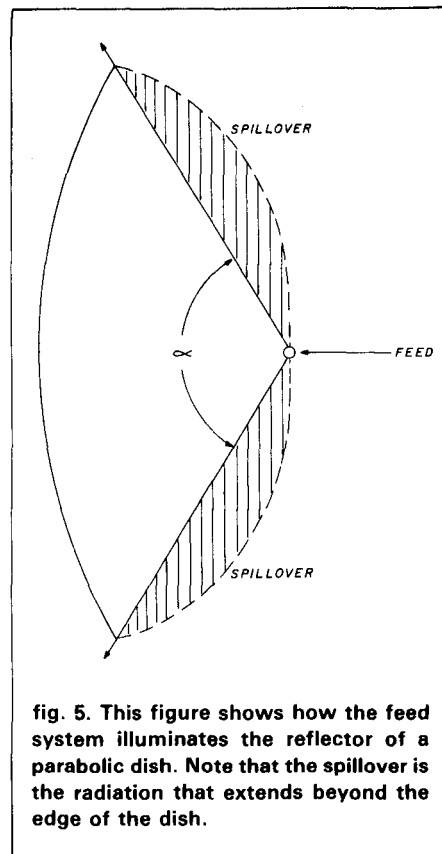


fig. 5. This figure shows how the feed system illuminates the reflector of a parabolic dish. Note that the spillover is the radiation that extends beyond the edge of the dish.

The reflector must follow a parabolic profile (see eqn. 5). This curve is calculated after the diameter and  $f/d$  ratio of the dish are selected. As dish diameter increases, greater care must be taken to maintain the shape of the reflector.

The depth of the reflector is the parameter that determines the focal length: the deeper the dish, the shorter its focal length. In a "deep" dish, where the  $f/d$  ratio is approximately 0.25, the focal point will be on a line parallel to the rim of the dish. The "flatter" the dish, the longer the focal length — and the more difficult it becomes to hold the feed system in place mechanically.

The  $f/d$  ratio, however, is probably the most important parameter when designing a parabolic dish antenna from scratch. Let's see why.

In order to use the parabolic dish reflector properly, the feed system must be placed at or near the focal point. Because this feed system "looks" into the dish from the focal point, it must illuminate the subtended



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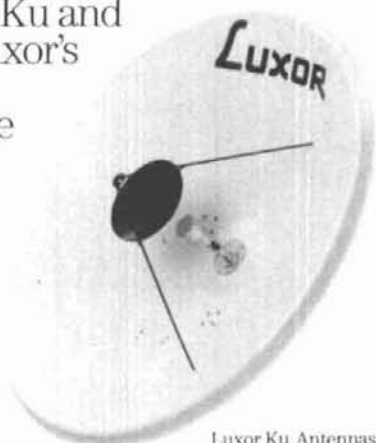
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angle between the rims of the dish with a properly tapered radiation pattern as shown in **fig. 5**. (More on this shortly.)

If you have a deep dish with an  $f/d$  ratio between 0.25 and 0.4, this subtended angle will be quite large — from 180 to 128 degrees, respectively. If a dish is relatively flat with an  $f/d$  ratio between 0.5 and 0.8, the subtended angle will be only 106 to 70 degrees, respectively. For convenience, various subtended angles versus  $f/d$  ratios have been plotted in **fig. 6**.

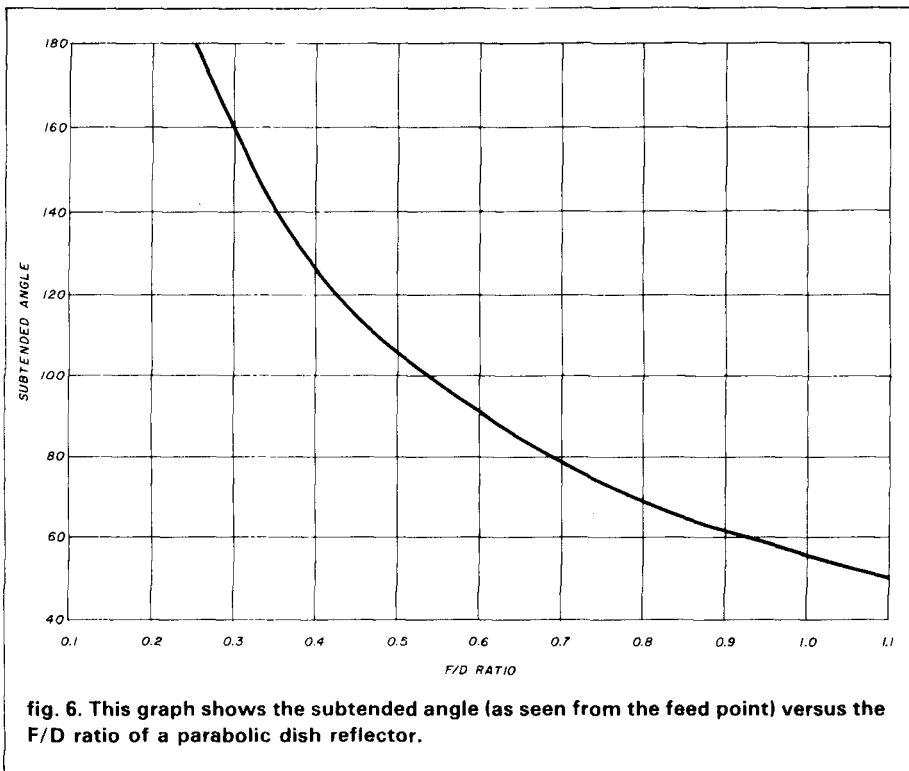
Why is this angle so important? The reasons are many, and all are related to the  $f/d$  ratio. Let's first look at some of the tradeoffs.

There are advantages to a low  $f/d$  ratio (0.25 to 0.4). This type of dish has a short focal length and hence the support of the feed system is easier from a mechanical standpoint. Generally speaking, the deep dish is quieter on reception. A 0.35 to 0.4  $f/d$  ratio is very common in commercial dishes.

There are also disadvantages to a low  $f/d$  ratio. The feed system has to see a wide angle as previously discussed; this makes the feed system more difficult to design. The proximity of the feed to the reflector can cause the feed impedance to change when it's mounted at the focal point. From a mechanical point of view, the deeper the curve, the more difficult is to fabricate the reflector. There's also greater likelihood that the polarity will become distorted. Usually the low  $f/d$  ratio dish demonstrates only moderate efficiency.

A high  $f/d$  ratio (0.5 to 0.6) offers several advantages. Because its illumination angle is narrower, the feed system is usually easier to design. The reflector has a flatter profile, making it easier to fabricate. Since the feed point is further from the reflector, it's less likely to be detuned by the reflector. Overall reflector efficiency is generally higher than in a dish with a low  $f/d$  ratio.

There are some disadvantages to a high  $f/d$  ratio. The feed system, for example, is much further from the reflector and hence more difficult to



**fig. 6.** This graph shows the subtended angle (as seen from the feed point) versus the  $F/D$  ratio of a parabolic dish reflector.

**table 2.** Gain and sidelobe levels versus illumination taper on a typical well-designed parabolic dish.

edge illumination in dB	typical level of first sidelobe	approximate overall aperture efficiency (%)
-6	-20.0	68.0
-10	-23.5	81.0
-15	-31.0	77.5
-20	-46.0	69.0

support. Even if the feed system is properly designed, there will be more spillover and hence more noise pickup than would be expected in a low  $f/d$  ratio dish.

When designing a dish, therefore, the main considerations are the mechanical design and the feed system, which are both governed by the  $f/d$  ratio as discussed. From our point of view, as Amateurs, an  $f/d$  ratio of 0.45-0.6 seems to be the best compromise since the feed system and the surface of the reflector are easier to design.

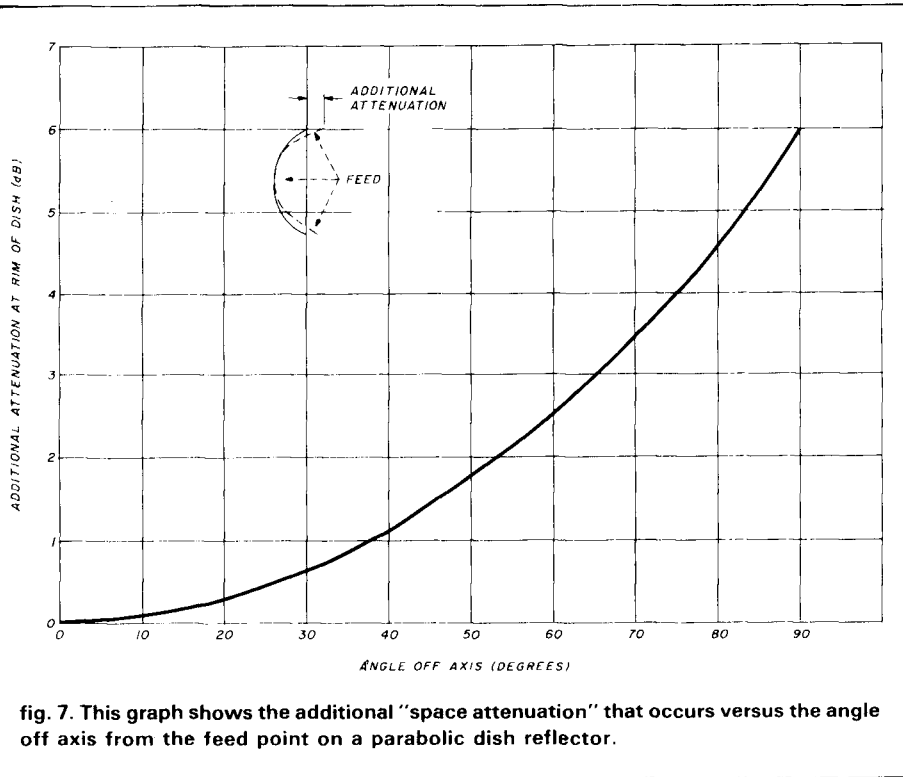
## feed systems

So far the feed system itself has

been mentioned only in passing. Let's look more deeply into the way it has to perform.

As I said earlier, the feed system must illuminate the subtended angle. Furthermore, a parabolic dish is symmetrical in the horizontal as well as the vertical plane, so the feed system must also be symmetrical in both planes.

Although actual feed systems will be discussed in next month's column, their requirements will be spelled out now. It would appear that the feed system should have a half-power beamwidth equal to the illumination angle as shown in **fig. 6**. However, if this were true, a considerable amount of the feed power would be lost



because of "spillover" (see **fig. 5**). Therefore the sidelobes would be high, and in the case of EME, considerable noise would be picked up off the rear of the dish, which is usually the warm earth at 290 degrees Kelvin. On the other hand, if the illuminator feed angle were too narrow, only the center of the reflector would be active and the efficiency of the antenna would decrease — but so would the sidelobes, etc.

Silver<sup>7</sup> and others has discussed this relationship in detail. Most engineers agree that for best overall performance, the optimum feed system should have its -10 dB points right on the rim of the dish. This will yield a reasonably clean pattern and fair gain. The first side lobes will be approximately 23 dB below the main beam. Some typical illumination tapers are shown in **table 2**.

Over-illumination with less than 10 dB feed system taper at the rim of the dish will cause spillover, lower gain, and sidelobes that will be less than 23 dB below the main beam. Conversely, if the dish is under-illuminated and the taper at the rim of the dish is too great,

the gain will decrease, as will the side lobes and the noise pickup.

Another factor must be considered: the distance from the reflector to the feed point changes across the reflector. So you can't assume that the feed must be optimum just because the feed system has a -10 dB beamwidth equal to the subtended angle. **Figure 7** shows this amplitude taper as a function of the angle as seen from the feed system. Hence this additional factor has to be taken into consideration when choosing the feed system and the f/d ratio. The lower the f/d ratio is, the greater the "space loss" taper at the edge of the dish will be.

### summary

This concludes part 1 of our discussion on the subject of reflector antennas. This month's column has described the relationship between electrical and mechanical considerations in designing a reflector-type antenna and, more specifically, a parabolic dish antenna.

It has also been shown that design tradeoffs are primarily linked to the f/d ratio chosen. Next month's column

will deal more with the mechanical design of a reflector and the electrical design of its feed system. Once you have this material in hand, you should be able to design your own parabolic dish antenna and know that it will work as planned!

### references

1. Joe Reisert, W1JR, "VHF/UHF World: Our Amateur Microwave Bands", *ham radio*, January, 1986, page 44.
2. A. W. Love, *Reflector Antennas*, IEEE Press, 1978.
3. Francis LeBaron, W1TOZ, "A Home-Built Parabolic-Type Reflector for 1296 Mc.," *QST*, April, 1961, page 11.
4. J. D. Kraus, "The Corner Reflector Antenna," *Proceedings of the IRE*, Volume 28, November, 1940, page 513.
5. H. W. Ehrenspeck, "The Backfire Antenna, A New Type of Directional Line Source," *Proceedings of the IEEE*, January, 1960, page 109.
6. H. W. Ehrenspeck, "The Short-Backfire Antenna," *Proceedings of the IEEE*, August, 1965, page 1138.
7. Samuel Silver, *Microwave Antenna Theory and Design*, Massachusetts Institute of Technology Radio Lab No. 12, Boston Technical Publishers, 1964.
8. John D. Kraus, *Antennas*, McGraw-Hill Book Company, 1950.
9. Henry Jasik and Richard C. Johnson, *Antenna Engineering Handbook*, Second Edition, McGraw-Hill Book Company, 1984.
10. Joe Reisert, W1JR, "VHF/UHF World: Stacking Antennas — Part 1," *ham radio*, April, 1985, page 129.
11. Joe Reisert, W1JR, "VHF/UHF World: Determining VHF/UHF Antenna Performance," *ham radio*, May, 1984, page 110.
12. *RF CAD Package — Version 3.50*, Computer-aided design package for radio frequency and microwave circuits and antennas (IBM PC and compatibles), by Joe Reisert, W1JR, and Gary Field, WA1GRC. Available from Ham Radio's Bookstore, Greenville, New Hampshire 03048 \$39.95 plus \$3.50 shipping and handling.)
13. Don Cook, K1DPP (see callbook) has a free program listing for Commodore 64 computers. Enclose SASE with request.

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# improving the audio on the ICOM IC-27

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The ICOM IC-27 FM transceiver remains, in my opinion, one of the most compact and versatile mobile units available. The performance of my IC-27A was very impressive, with just one noticeable exception: the received audio was poor. Low volume and poor treble response made many noise-free signals all but unintelligible. Many other Amateurs have experienced this problem as well. Fortunately, there's a very simple remedy.

My first inclination was to experiment with an external speaker. The speaker included in the IC-27 is very small. Often such small speakers are inefficient and have poor response. Yet experimentation with a much larger speaker with a more powerful magnet showed absolutely no discernible difference. The only way one could hope to increase the volume would be by mounting an external speaker closer to the user's ear. This would alleviate only part of the problem, however, since the tonal response would remain virtually unchanged. The latter fact was an important clue, because it led me to believe that the audio amplifier inside the IC-27 was the culprit.

## strategy

The solution to this problem is simple. Just change one resistor and one capacitor in the audio section. There's absolutely no reason to fear the operation; it's very simple. ICOM has provided excellent schematics with the radio, the board layout is not terribly compact in this area, and all cables running to the important circuit board are provided with well labeled pull-off connectors in an unambiguous configuration. Aside from forgetting to replace a connector, it's virtually impossible to connect anything incorrectly.

As shown in the ICOM schematic, not reproduced here, Q5 and Q6 form an active filter which seems to

effectively filter the intelligibility of many Amateurs' speech. Capacitor C67 was found to form the bottleneck; a smaller value is required here. This greatly improves the treble response.

The audio output power was increased by changing the feedback resistor, R31, of the audio power amp, IC6 (on the ICOM schematic). It was discovered that a larger value would give greater gain while still not introducing objectionable distortion.

## modification procedure

Begin the modification by turning the transceiver over (speaker side up), and removing the four screws holding the bottom cover. Carefully place the bottom cover to the side (as shown in fig. 1) so as not to strain the speaker wires. The connector for the speaker wires can then be pulled at the circuit board.

The objective is to remove the circuit board in order to gain access to the parts which must be changed. Carefully remove connectors J2, J6, J10, and J12. With your fingers, remove the cover plate of the synthesizer section (it's the large shiny box on the right-hand side). Remove the four screws in the corners of the large circuit board. Remove J1 (the entire circuit board at the rear of the unit). Remove the two heat sink screws on IC5 and IC6. Remove the hex spacer formerly under the rear circuit board.

At this point, the entire circuit board can be lifted out. Carefully pull it out and locate the audio section toward the front on the left side, as viewed from the component side. Locate C67. This is a 0.01  $\mu$ F capacitor near IC6. Using a solder wick or a solder sucker, remove C67 and replace it with a tiny 0.001  $\mu$ F capacitor. A small ceramic part will do nicely. Then locate R31. This is a 150-ohm, 1/8 watt resistor near J6. Replace this with a 270-ohm resistor. If possible, use a 1/8 watt part so that it will fit easily in the circuit board. Clean your solder connections and carefully check for solder bridges.

This completes the modifications. Replace the circuit board and reverse the disassembly procedure, being careful to replace all removed connectors.

By Edward Richley, KD8KZ, 41 High Point Circle, Naples, Florida 33940

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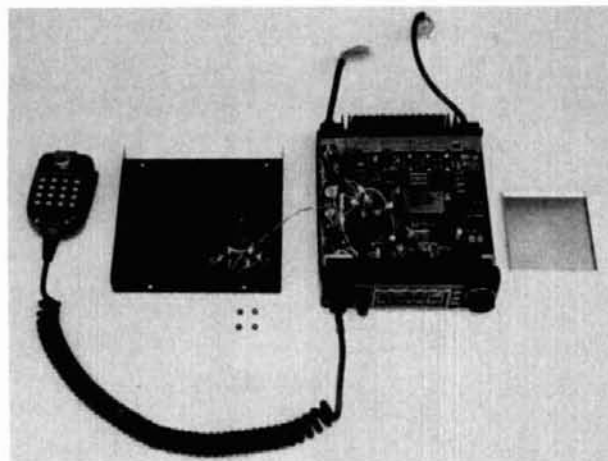


fig. 1. The ICOM IC-27 is easily disassembled for modification.

## results

After performing these modifications, I was much happier with the IC-27. Audio volume and clarity are much better than with the original unit, even with the original speaker. In fact, I seriously doubt the need for an external speaker. The internal speaker provides plenty of power, even in my very noisy automobile. I'm sure other Amateurs will agree that this modification makes an otherwise superb radio even better.

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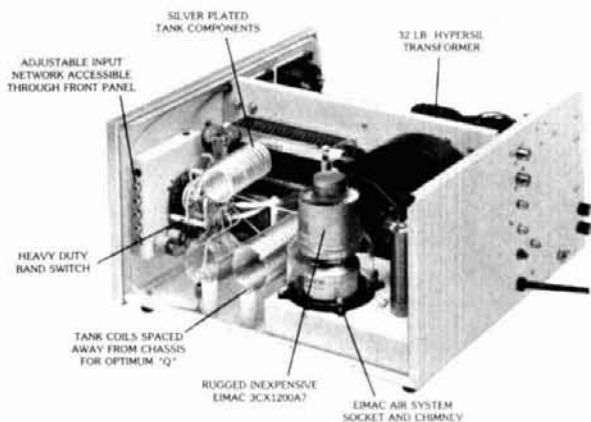
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The Ameritron ATR-10 has a unique bandpass network that provides superior harmonic suppression and image rejection. It will safely handle 900 watts of envelope power from 160 through 10 meters. A heavy duty antenna switch permits selection of 5 outputs. It has a peak reading wattmeter, SWR bridge and a dual ratio balun.

duty antenna switch permits selection of 5 outputs. It has a peak reading wattmeter, SWR bridge and a dual ratio balun.

### ATR-15 TUNER

The Ameritron ATR-15 is a 1500 watt "T" network tuner that covers 1.8 through 30 MHz in 10 dedicated bands. Handles full legal power on all amateur bands above 1.8 MHz.

Five outputs are selected from a heavy duty antenna switch. The ATR-15 has a peak reading watt meter, SWR bridge and a dual ratio balun. Size: 6"H. x 13 1/4"W. x 16"D.



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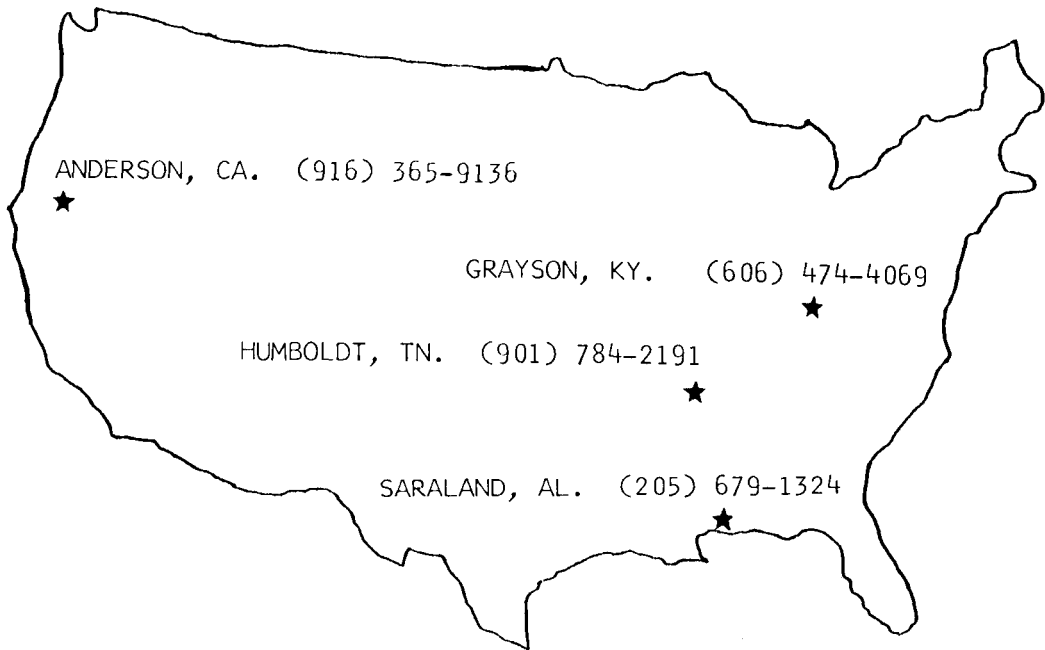
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# ham radio TECHNIQUES

Bill Over  
W6SAI

## what others think of us

When asked about the place of Amateur Radio in today's rapid technological expansion, academician Vladimir Aleksandrovich Kotelnikov, Vice President of the Academy of Sciences of the USSR and Director of the Institute of Radiotechnology and Electronics of the Academy of Sciences of the USSR, said (in part), "One of the needs of man is the need to create. Amateur Radio opens up broad possibilities in this connection for youths as well as for adults. . . ."

"Amateur Radio has been and remains a wonderful school for mass training of personnel for radio electronics. Many young people entered radio electronics via Amateur Radio, judging by our experience. . . ."

"The main goal of Amateur creativity has remained unchanged — to attract youth to active participation in the struggle for technical progress and to teach inventiveness, innovation, and improvements in technology. This is very important for our country." (And for ours, too — Ed.)

## quad falling apart?

One of the problems with the multi-element quad antenna is keeping it in the air during the months of bad weather. The point at which the loop wire and support structure meet is an area of particular weakness in this design. If fiberglass or bamboo poles are used, the copper antenna wire will "saw" back and forth at this point under the movement of the element in the wind. This sawing motion often results in the breaking of either the support pole or the wire, and the whole antenna must be taken down for repairs.

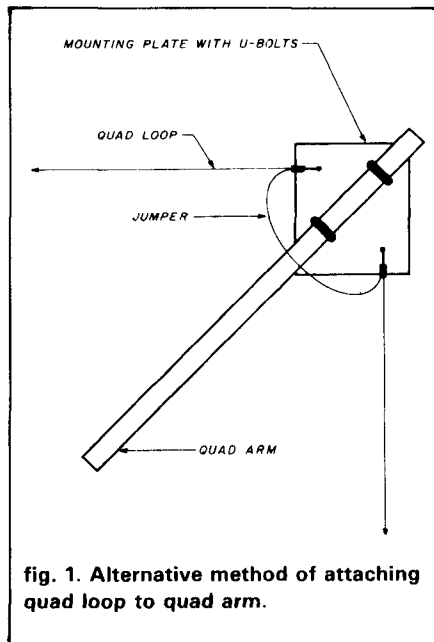


fig. 1. Alternative method of attaching quad loop to quad arm.

Figure 1 shows a novel approach to this problem. An insulating plate (made of fiberglass or formica, for example) is affixed to the quad arm with two U-bolts. The quad wire loop is then attached to holes drilled in the plate and the connection is made as shown in fig. 1. Since I don't have a quad up right now, I can't vouch for the idea, but it looks like a good one, and Amateurs planning to erect quads this spring may be interested in trying out this arrangement.

## the 160-meter antenna at DJ8WL

DJ8WL, who just returned to Germany after three months in Salt Lake City sent me a sketch of the 160-meter antenna he's using in Germany. Those who've heard his signal can attest to the excellence of the antenna design (fig. 2), which he's used since fall, 1984.

His antenna is about 103 feet high (31.4 meters) and is center-loaded by a high-Q coil (L1). A second loading coil is placed at the 19.7 foot (6 meters) level (L2).

Peter uses 50 radials, each 3/8-wave length (205 feet/62.42 meters) long. The feedpoint resistance was measured to be 38 ohms. When only 16 radials were used, the feedpoint resistance was 40 ohms. He estimates his ground resistance to be 9 ohms, so the antenna is about 63 percent efficient.

Antenna response is quite broad, showing less than 1.5:1 SWR over the range of 1800 to 1900 kHz. Peter reports working 9J2JN and LU9EIE the first morning the antenna was on the air!

Peter's antenna was mounted in a tall tree. The top section was made of a fiberglass rod with wire attached, and the lower sections are made of wire. Compared to an inverted-V slung from the same tree at the 80-foot (24.38 meter) elevation, the ground plane produced DX signal reports that were up between 1 to 2 S-units.

DJ8WL's 160-meter DX record with this antenna — as of spring, 1985 — was 135 countries.

## aircraft enhancement of VHF/UHF signals

Why does the 2-meter path between San Francisco and Los Angeles pop open every so often, usually in the evening, for just a few minutes? This interesting opening seems to be duplicated in other parts of the world, apparently on a hit-or-miss basis. Doug McArthur (VK3UM) and Ralph Kettle (VK1RK) noticed strange openings on their path, as well as similar openings to VK2ZAB. Path loss was

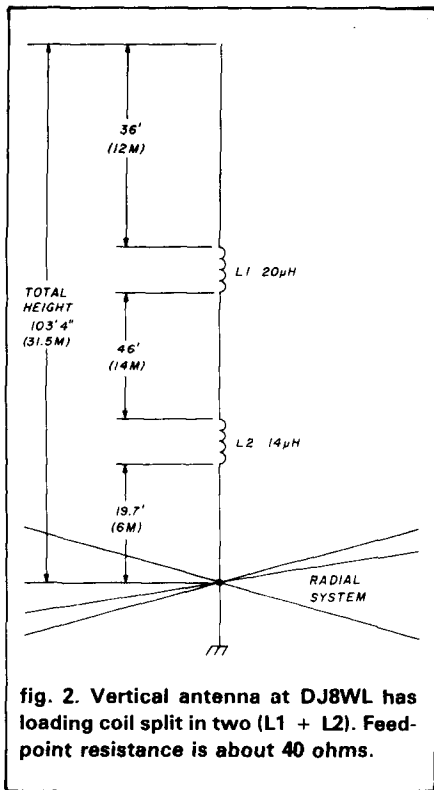


fig. 2. Vertical antenna at DJ8WL has loading coil split in two (L1 + L2). Feed-point resistance is about 40 ohms.

calculated to be  $-245$  dB. The use of medium power, 36-element arrays, and low noise receivers showed that the paths were open for more time than the calculations would indicate. The Melbourne-Canberra path, in particular, had mountainous terrain along the route so direct (i.e., line-of-sight) communication was out of the question, except for occasional tropospheric enhancement. What was causing the strange VHF propagation?

The time of the opening seemed to be related to aircraft passing between the two stations. In particular, two commercial airliners flying from Sydney to Melbourne were midpath at the times of the enhanced propagation.

Upon investigation, it seemed that the height of the flight path and distance of the aircraft from the stations did not tally with the signals received. The signals were too strong and varied markedly with the weather.

VK3UM and his colleagues in the investigation believe that the aircraft are the cause, but not the actual media of the enhanced propagation.

Possible explanations were reflec-

tions caused by the condensation trails ("contrails") left by the aircraft flying at about 30,000 feet, or perhaps refraction caused by the air turbulence wake (temperature effect or vortex turbulence).

The size of the aircraft apparently influenced the enhancement, with the highest level obtained from 747s and DC10s. But even aircraft as small as the Fokker F28 provided a good degree of path enhancement. Multiple aircraft, on the other hand, resulted in multipath effects, making copy difficult.<sup>2</sup>

### some good news?

It's reported in the technical literature that the new AN/TPS-118 over-the-horizon radar under construction in Maine will soon be on the air. It will provide radar detection of planes at ranges from 500 to 1800 miles (804 to 2897 km). The device uses a transmitting antenna more than 3600 feet long and radiates up to 100 Megawatts of power (effective radiated power) in the 5 to 28 MHz frequency range. Two other sites are planned, one covering the Pacific Coast and one in the Midwest to fill in the skip zones of the other two. That adds up to *three* of these giants grinding away in the continental United States. Let's hope they're programmed to stay out of the ham bands!

### a zig-zag dipole antenna

Most compact dipole antennas make use of some form of lumped loading such as an inductor placed in series with the antenna. A few years ago the "zig-zag dipole" was investigated at Hosei University, Tokyo, Japan (fig. 3).

One of the more interesting zig-zag dipoles developed and tested used a 0.5 wavelength wire folded back so that the overall length was about 24 percent less than a full-size dipole. The feedpoint resistance was 46 ohms. The included angle was about 130 degrees and each leg of the configuration was as indicated in fig. 3.

No mention was made of bandwidth, but it seems to me that the

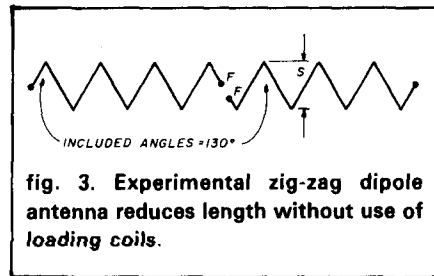


fig. 3. Experimental zig-zag dipole antenna reduces length without use of loading coils.

antenna configuration may provide improved bandwidth because it resembles a "fat" dipole. Some enterprising experimenter should try this antenna on the 80-meter band and see how it performs.

### an inexpensive 160-meter antenna that works

No room for a quarter-wave vertical with 120 radials for 160-meter DX work? Too bad. Join me in crying the blues! About the best I can do is a random-length wire running from the house to my nearby antenna tower. I work it against the residence plumbing system as a ground. Recently I added two 8-foot (2.4 meters) ground rods, one at each end of the house, and tied them to the copper water pipe system. So far, so good.

After I'd been working with various end-fed antenna systems for over six months, the back yard was littered with bits of copper wire. I finally ended up with a wire antenna that worked well, although not quite as well as the antennas the "big guns" were using. But if you share my problem of limited space and don't want to grow an antenna farm, this antenna is ideal for you.

Basically, it's a wire about 155 feet (47.24 meters) long. This makes it longer than a quarter-wavelength at 1.8 MHz (130 feet/39.62 meters). The feedpoint impedance of the longer wire is inductive and slightly higher than that of the quarter-wave wire. The inductive reactance is tuned out by a series-connected capacitor and the feedpoint resistance of the antenna (about 23 ohms) is transformed by a shunt inductor to 50 ohms (fig. 4).

This design provides an inexpensive matching system to provide a 50 ohm

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Band	Kit	Wired
10M,6M, 2M,220	\$680	\$880
440	\$780	\$980

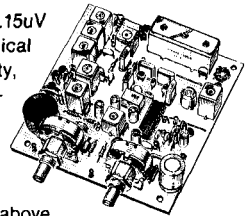


## FEATURES:

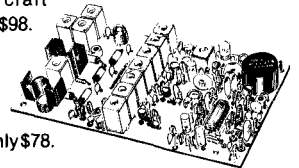
- SENSITIVITY SECOND TO NONE; 0.15 uV (VHF), 0.2 uV (UHF) TYP.
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- **R110 VHF AM RECEIVER** kit for VHF aircraft or ham bands or Space Shuttle. Only \$98.



- **T51 VHF FM EXCITER** for 10M, 6M, 2M, or 220 MHz. 2 Watts continuous, up to 3W intermittent. \$68/kit.
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- **VHF & UHF LINEAR AMPLIFIERS.** For either FM or SSB. Power levels from 10 to 45 Watts to go with exciters & xmtg converters. Several models. Kits from \$78.



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Antenna Input Range	Receiver Output
28-32	144-148
50-52	28-30
50-54	144-148
144-146	28-30
145-147	28-30
144-144.4	27-27.4
146-148	28-30
144-148	50-54
220-222	28-30
220-224	144-148
222-226	144-148
220-224	50-54
222-224	28-30

### VHF MODELS

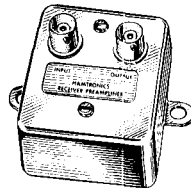
Kit with Case	\$49
Less Case	\$39
Wired	\$69

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Kit with Case	\$59
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SCANNER CONVERTERS Copy 806 MHz band on any scanner. Wired/tested ONLY \$88.

## LOW-NOISE PREAMPS



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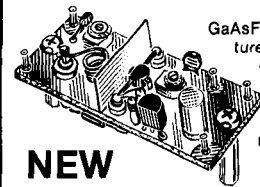
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- Wide Dynamic Range for Overload Resistance
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MODEL	TUNES RANGE	PRICE
LNG-28	26-30 MHz	\$49
LNG-50	46-56 MHz	\$49
LNG-144	137-150 MHz	\$49
LNG-160	150-172 MHz	\$49
LNG-220	210-230 MHz	\$49
LNG-432	400-470 MHz	\$49
LNG-800	800-960 MHz	\$49

## MINIATURE PREAMPS



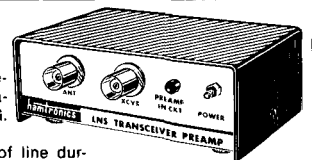
GaAsFET Preamps with features similar to LNG, except designed for LOW COST and SMALL SIZE: only 5/8" W x 1-5/8" L x 3/4" H. Easily mounts inside many radios.

NEW

MODEL	TUNES RANGE	KIT	WIRED
LNW-144	120-150 MHz	\$19	\$34
LNW-160	150-200 MHz	\$19	\$34
LNW-220	200-270 MHz	\$19	\$34
LNW-432	400-500 MHz	\$19	\$34

## IN-LINE PREAMPS

NEW



GaAsFET Preamp with features like LNG. Automatically switches out of line during transmit. Use with base or mobile transceivers up to 25W. Tower mtg hdwr incl.

MODEL	TUNES RANGE	KIT	WIRED
LNS-144	120-150 MHz	\$68	\$98
LNS-160	150-180 MHz	\$68	\$98
LNS-220	200-240 MHz	\$68	\$98
LNS-432	400-500 MHz	\$68	\$98

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Kit \$79  
Wired \$149  
(Specify band)

Exciter Input Range	Antenna Output
28-30	144-146
28-29	145-146
28-30	50-52
27-27.4	144-144.4
28-30	220-222*
50-54	220-224
144-146	50-52
50-54	144-148
144-146	28-30

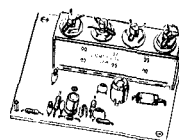
For UHF, Model XV4  
Kit \$99  
Wired \$169

Exciter Input Range	Antenna Output
28-30	432-434
28-30	435-437
50-54	432-436
61.25	439.25
144-148	432-436*

VHF & UHF LINEAR AMPLIFIERS. Use with above. Power levels from 10 to 45 Watts. Several models, kits from \$78.

## HELICAL RESONATOR PREAMPS

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Model	Tuning Range	Price
HRA-144	143-150 MHz	\$49
HRA-220	213-233 MHz	\$49
HRA-432	420-450 MHz	\$59
HRA-( )	150-174 MHz	\$54
HRA-( )	450-470 MHz	\$64

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feedpoint, required by today's modern transceivers. The solid-state amplifiers are not very forgiving with respect to oddball antenna feedpoint impedances, and operation of the 160-meter band stretches the capability of the solid-state amplifier, even under the best conditions.

But this antenna solves that problem. You can change the antenna length and compensate for it with the variable capacitor. As the antenna is shortened toward the quarter wavelength point, the capacitor value increases. As the antenna approaches three-quarter wave resonance, the value of the capacitor diminishes. A happy medium is reached when the antenna is about 0.275 wavelength long. If the inductor and capacitor are variable, the operator can scoot from one end of the band to the other in just a few seconds.

Operational bandwidth of the antenna is quite good; an SWR of better than 1.5:1 can be maintained over 50 kHz without touching the network controls. I tune up at 1825 kHz and am able to QSY up and down 25 kHz at the touch of the transceiver dial.

How well does it work? Well, I'll let you know the results after the next 160-meter DX contest! So far, it seems to be the best wire I've ever had on the "low band."

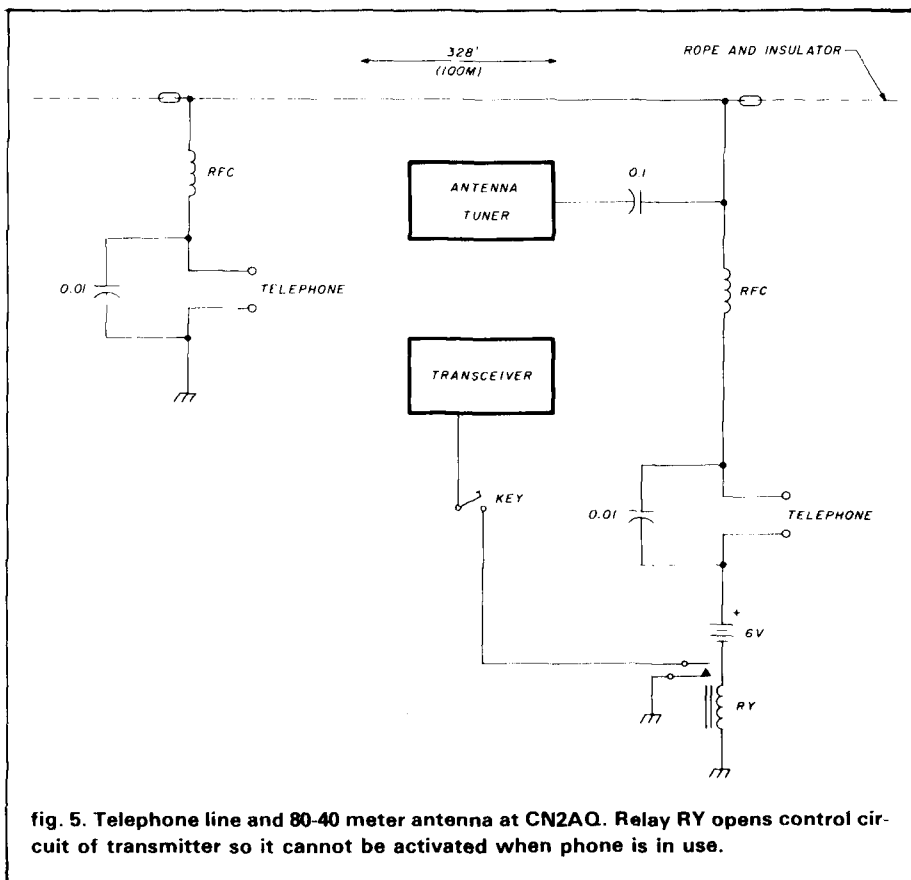
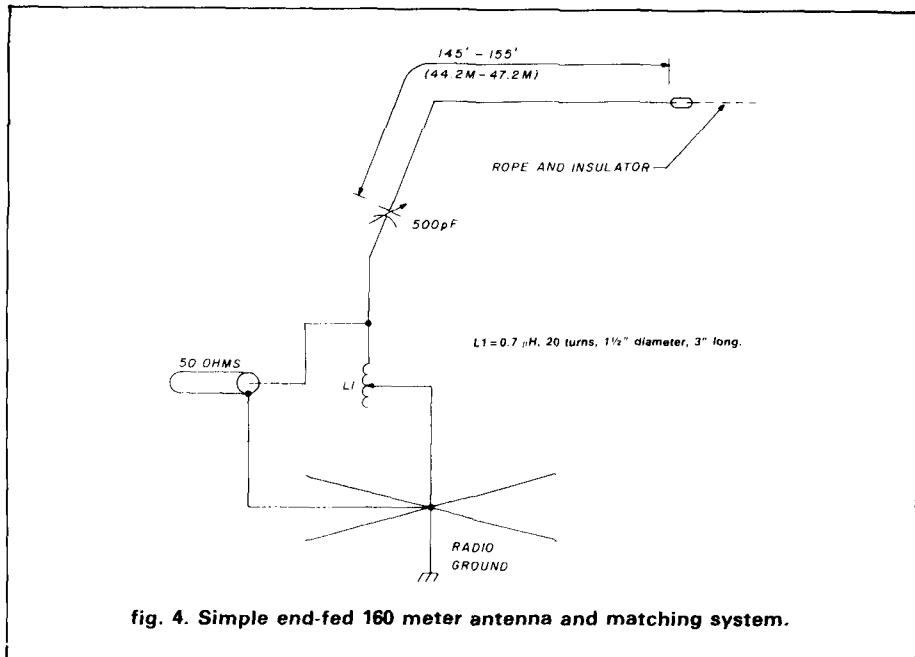
### building the tuner

You can build the tuner on a metal chassis and panel, but it's not necessary (see photo A). My tuner is built on a plywood base with a micarta™ panel. The unit is 8 x 8 inches (25 x 25 x 25 cm). I recommend using a vernier drive on the capacitor because the setting for lowest SWR is quite sharp. The setting of the shunt inductor, on the other hand, is less critical and the counter dial is a luxury. The 3 ampere RF thermocouple meter is very handy for tuneup, so if you can find one at a flea market, buy it and use it. I short mine out with a clip lead after tuneup to keep the meter from jumping around when I'm transmitting.

### the 80-40 meter antenna at CN2AQ

Have you heard the strong signal of CN2AQ on 80 meters? He has an

antenna that doubles as a telephone line! Look at fig. 5. The 328 foot (99.91 meter) wire runs between two buildings. RF chokes at each end of the



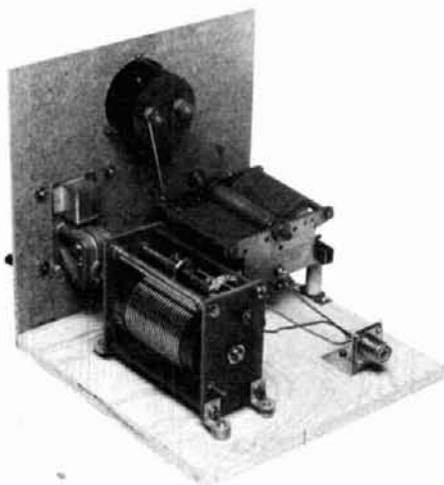


Photo A. W6SAI tuner is built on plywood base.

wire isolate it for the telephone service, in which the return circuit is via ground. In order to prevent the transmitter from being activated when the telephone circuit is in use, a series-connected relay opens the control circuit of the exciter. Now, that seems to be a very practical idea!

### what about your antenna?

The sunspot cycle is at low ebb and interest is growing in the 160 and 80-meter bands. I would be interested in hearing about *your* antenna for the low bands. Please send the information to me, care of *ham radio* magazine; the most interesting antennas will be discussed in this column. I hope to hear from you!

#### references

1. *Amateur Radio*, Journal of the Wireless Institute of Australia, May, 1985.
2. *Amateur Radio*, Journal of the Wireless Institute of Australia, July, 1985.
3. Nakano, Tagami and Yoshizawa, "Shortening Ratios of Modified Dipole Antennas," *IEEE Transactions on Antennas and Propagation*, Volume AP 32, No. 4, April 1984.

### ham radio

#### Invitation to Authors

*ham radio* welcomes manuscripts from readers. If you have an idea for an article you'd like to have considered for publication, send for a free copy of the *ham radio* Author's Guide. Address your request to *ham radio*, Greenville, New Hampshire 03048 (SASE appreciated).

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And because it is inherently resonant, the KD14-HW can also be easily removed with a length of coax.

The KD14's flexible, easy-to-get-along-with radiating element measures a scant 12 inches. At the base is a 3/4 inch impedance transformer that gives added strength.

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\*For units with BNC output.



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# EME link calculator program

Maximize your  
station's performance  
with knowledge  
of tradeoffs

## In trying to set up an EME (moonbounce) station

I found it difficult to make trade-offs in terms of antenna gain, coax line losses, preamplifier placement, and output power. What I needed was an easy way to weigh the different parameters against each other. Looking through a few books, I found what I was looking for in the *ARRL Handbook*, the *RSGB VHF-UHF Manual* and in an article by R. Lentz.<sup>1,2,3</sup>

By taking pieces of information from all three sources, I was able to figure out how to vary all the station information in order to calculate the link budget signal-to-noise ratio. However, it became apparent that getting answers by punching buttons on my hand calculator would take a few nights. Also, I was mixing up the answers and station data so much that I couldn't figure out what answer belonged to what station data. Figuring that there had to be a better way, I looked for a computer program to do the job. Not finding one, I wrote the BASIC program included in this article (fig. 1). I used Microsoft BASIC for the IBM PC, so it should be able to run as is or with little modification on other PCs or compatibles.

After the requested data is entered, the program provides signal-to-noise ratio (SNR), effective isotropic radiated power (EIRP), and the system noise temperature. Using these figures, you can change the input parameters and see how to best assemble your EME system. With the computer doing most of the work, it's easy to use real numbers, rather than using whatever is convenient, as I did with the calculator.

Both the ARRL and the RSGB handbook examples placed the receive preamplifier at the antenna. They then set the line loss at a convenient zero dB. Since no-loss coax phasing lines don't exist, those example calculations don't really show you what is happening in an antenna array. On the other hand, the program shows that even a 0.5 dB phasing line loss will have a significant effect on the performance at 432 MHz. The computer program provides performance infor-

mation about an EME station while allowing you to easily change all the station parameters.

## realistic data is needed

The data requested by the program is generally familiar. The only data I had trouble figuring out was the sky temperature, which is the actual sky temperature the antenna sees. Don't confuse it with the array temperature, which is sometimes given in antenna articles. Try about 10 to 35 degrees Kelvin for 432 MHz and around 175 to 200 degrees Kelvin for 144 MHz.<sup>4</sup> (Use the lower numbers if your system is in the country and the higher numbers if you live in or near an urban area). At low elevations the antenna will see the earth at 290 degrees Kelvin. This program assumes you're looking high enough with your antenna so that the antenna's main and side lobes clear the earth. After a little practice with the program, you can set the sky temperature higher; this will demonstrate earth effects on EME communications at moon rise or moon set. I left the bandwidth as a variable. Most of the time it should be set at 100 Hz, as the ear and mind can provide that much filter capability. You can set the bandwidth to 1800 Hz to see what kind of signal is required for EME SSB.

The program doesn't provide absolute answers. You can't take an existing station, enter its data into the program, and come out exactly with the way the system works. The real world, after all, includes other factors such as Faraday rotation, noise from you don't know where, and systems built not quite the way they should be. The real benefit of the program is to show the relative merit (or lack of merit) of different ways of putting together an EME station. For instance, what's the benefit of running 1.5 kW instead of 800 Watts? How much better is a 0.3 dB noise figure preamp than a 0.6 dB preamp? Does it make any difference if you use Belden 9913 for phasing lines instead of RG-213/U? Try it and see — you may be surprised.

## program structure

The program is divided into six parts: constants, data input, calculations, screen output results, print results and program end. **Lines 10 to 35** contain the program header and set up constant values. **Lines 30 and 35** provide a log to base 10 function as most BASICs have only a log to the base e function. **Lines**

By David Engle, KE6ZE, 1063 Summerwood Court, San Jose, California 95132

```

10 ' Program to calculate signal to noise ratios for EME operations.
11 '     David Engle, KE6ZE           September 1985
12 '
20 K = 1.38E-23 ' Boltzman's constant.
25 TL=290.0 ' Temperature of receive feed line.
30 LOG10E=.434294482 'is log to the base 10 of e.
35 DEF FNLOG10(V)=LOG(V) * LOG10E ' Log to base 10 function
100 ' Get data to set up calculations.
110 PRINT" EME Signal to Noise calculator program" : PRINT
120 INPUT" ENTER FREQUENCY, MHz: ",FREQ
130 INPUT" ENTER TX ANTENNA GAIN, dBi: ",GT
140 INPUT" ENTER TX OUTPUT POWER, WATTS: ",P
150 INPUT" ENTER TX LINE LOSS, dB: ",LT
160 INPUT" ENTER RX ANTENNA GAIN, dBi: ",GR
170 INPUT" ENTER RX LINE LOSS, dB: ",LL
180 INPUT" ENTER RX NOISE FIGURE, dB: ",RN
190 INPUT" ENTER RX BANDWIDTH, Hz: ",B
200 INPUT" ENTER SKY TEMPERATURE, Deg K: ",SKY
210 PRINT
300 'Start calculations.
310 'Transmitter power.
320 PO = 10.0 * FNLOG10(P)
340 'Receiver noise level.
350 TR=((10.0^(RN/10.0)) -1.0 ) * 290.0 'Noise figure to noise temp
360 LR = 10.0^(LL/10.0) ' Noise figure (dB) to noise factor.
370 TS = SKY + ((LR - 1)* TL) + (LR * TR)
380 PN = 10.0 * FNLOG10(K*TS*B)
390 'Path loss.
400 PL = 8.72 * LOG (432/FREQ) - 261
410 'Signal to noise.
420 SNR = PO - LT + GT + PL + GR - PN
430 BAND% = INT (FREQ)
440 EIRP =INT (P*10^((GT-LT)/10.0))
500 'Display the results.
510 PRINT"Transmit EIRP =";EIRP;"Watts,";
520 PRINT" System Noise Temp =";(INT (TS));"Degrees K."
530 PRINT" Signal-to-noise ratio at:"," Perigee","Mid.,","Apogee."
540 PRINT" for ";BAND%;"MHz band is:", SNR, SNR-1, SNR-2
550 PRINT
600 'Print the results.
610 OPEN "LPT1:" FOR OUTPUT AS #1
620 PRINT#1,
630 PRINT#1,"FREQUENCY =";FREQ;"MHz"
640 PRINT#1,"TX ANTENNA GAIN =";GT;"dBi,";
650 PRINT#1," TX OUTPUT POWER =";P;"Watts,";
660 PRINT#1," TX LINE LOSS =";LT;"dB"
670 PRINT#1,"RX ANTENNA GAIN =";GR;"dBi,";
680 PRINT#1," RX LINE LOSS =";LL;"dB"
690 PRINT#1,"RX NOISE FIGURE =";RN;"dB,";
700 PRINT#1," RX BANDWIDTH =";B;"Hz"
710 PRINT#1,"SKY TEMPERATURE =";SKY;"Deg K"
720 PRINT#1,
730 PRINT#1,"Transmit EIRP =";EIRP;"Watts,";
740 PRINT#1," System Noise Temp =";(INT (TS));"Degrees K."
750 PRINT#1,"Signal-to-noise ratio at:"," Perigee","Mid.,","Apogee."
760 PRINT#1," for ";BAND%;"MHz band is:", SNR, SNR-1, SNR-2
770 PRINT#1,
780 CLOSE #1
900 INPUT" Do you wish to continue? (Y/N) ",ANS$
910 IF ANS$="Y" OR ANS$="y" THEN 120

```

fig. 1. EME station optimization program listing.

Frequency = 144 MHz  
 TX Antenna Gain = 21 dBi, TX Output Power = 1500 Watts,  
 TX Line Loss = 0.5 dB

RX Antenna Gain = 21 dBi, RX Line Loss = 0.5 dB

RX Noise Figure = 0.5 dB, RX Bandwidth = 100 Hz

Sky Temperature = 170 Deg K

Transmit EIRP = 168302 Watts, System Noise Temp = 245  
 Degrees K.

Signal-to-noise ratio at:	Perigee,	Mid.,	Apogee
for 144 MHz band is:	6.548783	5.548783	4.548783

fig. 2A. Typical data displayed in run of SNR program.

100 to 210 inquire and retrieve the station data from the operator (you). Lines 300 to 440 do the calculations and come up with the answers. Line 350, which converts the preamplifier gain in dB to noise temperature, is from the RSGB manual. Line 360 converts the receiver (preamplifier) line loss into a ratio.<sup>3</sup> Line 400 provides the path loss. (The path loss is an approximation — a little high at 50 MHz, right on at 432 MHz, and a little low at 2304 MHz. All are within 1 dB.) Lines 500 to 550 display the answers on your screen. Lines 600 to 780 print both the input data and the answers on your line printer. If you have no printer, omit lines 600 to 780. Line 610 sets the printer up. If your computer calls its printer something other than "LPT1," you'll have to change this line accordingly. Lines 900 to 999 re-run or end the program.

### sample run checks program

Figure 2A contains a set of data to run through the program after you get it entered in the computer. This can be used to check the accuracy of what you've typed in. If you don't get the answers listed to within 0.1 dB, exit the program by answering "N" to the question, "Do you wish to continue?" You should still be running BASIC at this point, so you can look at the intermediate answers from the program. Simply type "PRINT PO," "PRINT PL," and those values will be printed on the screen. Any of the intermediate values used in the program (e.g., PO, TR, LR, TS, PN, PL, SNR) may be looked at in this manner. Figure 2B contains the set of intermediate values generated during the fig. 2A example. If your answers are different from these examples, then you have an error in one of the previous lines that works on that variable.

I hope this program can help you demystify the optimization of your EME station. A couple of the more interesting things I noticed were the effects of phasing line loss and preamplifier noise figure on the

PO = 31.760  
 TR = 35.385  
 LR = 1.122  
 TS = 245.088  
 PN = -184.708  
 PL = -251.420  
 SNR = 6.548

fig. 2B. Intermediate values generated for fig. 1 results.

system's performance. These effects are easily noticed in the system noise figure. Fire it up and plug in your numbers. It may be easier to improve your system than you think!

### references

1. Charles Hutchinson, K8CH, Editor, *The ARRL 1985 Handbook for the Radio Amateur*, American Radio Relay League, Newington, Connecticut, 62nd Edition, Chapter 23, pages 11 and 12.
2. D.S. Evans, G3RPE, and G.R. Jessop, G6JP, Editors, *VHF-UHF Manual*, Radio Society of Great Britain, London, 3rd Edition, Chapter 9, pages 12 to 14.
3. R. Lentz, DL3WR, "Noise in Receive Systems," *VHF Communications*, 4/1975, pages 217 to 235.
4. Steve Powlisken, K1FO, "Stacking Yagis Is A Science," *ham radio*, May, 1985, pages 18 to 23.

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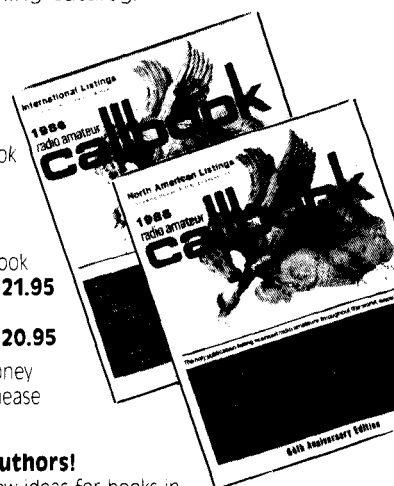
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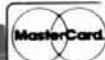


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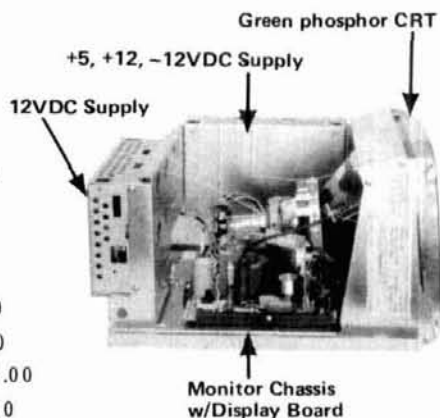
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IR Scope part no. ELD Shpg. Wt. 7 Lbs. \$735.00 ea.

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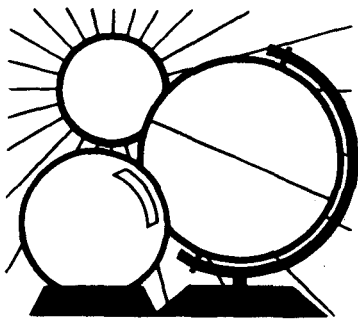
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# DX FORECASTER

Garth Stonehocker, KØRYW

## sunspots and MUFs

Because we're nearing the 11-year sunspot number minimum, the Institute for Telecommunication Science study comparing MUF distribution of values for low, medium, and high sunspot numbers should be of interest. **Table 1** (similar to last month's) lists the ratios of the 10- and 90-percentile monthly median MUF values. The data is separated into day and night groups over three solar activity ranges: low (68-88) sunspots in the years 1954-55; medium (90-115) in the years 1961-62; and high (200-285) in the years 1957-58 at various control point latitudes. The upper decile values (90 percent) use the column head + % and the lower decile (10 percent) by - % in the table. A separate listing is provided for daytime and nighttime periods.

Notice that greater deviations from median occur in the high (70 degree) and low (10 degree) latitudes in all sunspot categories regardless of whether it's local daytime or nighttime. However, the largest deviations occur during a high sunspot number year and at night. This increased MUF is from the solar flare particles arriving via the solar wind at the polar ionosphere down the open geomagnetic field lines from the sun (see the geomagnetic field drawing in "DX Forecaster," June, 1985, page 102) on the day side of the earth. On the night side the particles come into the ionosphere from the stored particle areas (Van Allen belts) along the closed and tail geomagnetic field lines.

The exception to the foregoing pattern is the 20-degree latitude night values at low and medium sunspot numbers. Here the geomagnetic variations help the ions drift upward along the closed field lines until within 20 degrees of the geomagnetic equator. This is a winter nighttime effect during medium to low sunspot numbers. Here again is evidence of trans-equatorial DX propagation; it is accompanied by an F-region trough (with low MUFs) just south of the auroral zone. The low MUFs in the trough are shown by the large - % numbers at 70 degrees latitude during the night. The increased geomagnetic variability during low to medium sunspot numbers results from a stronger solar wind stream through a thinning

solar corona while the sun is yet somewhat active. This data, the MUF distribution statistical trends of propagation effects, can be used to understand and improve DX operating skills.

## last minute forecast

The best DX conditions for the higher frequency bands are expected during the first and last weeks of February. The solar flux base level should increase about 5 units in January and February. So look for some increase in MUFs in the midlatitudes as last month's table showed. Trans-equatorial propagation should be good and enhanced by some geomagnetic disturbances around the 10th and 24th of the month. The lower frequency bands are expected to be very good

table 1. Variation in the ratio of monthly median MUF values.

Latitude	Sunspot Range	- % Day	+ %	- % Night	+ %
70	Low	22	23	28	29
	Medium	24	29	23	30
	High	26	29	27	30
50	Low	19	15	21	21
	Medium	21	17	21	21
	High	22	22	21	18
30	Low	17	17	22	26
	Medium	19	17	24	25
	High	14	17	18	18
20	Low	21	19	26	31
	Medium	18	19	27	34
	High	12	14	21	26
10	Low	14	18	26	27
	Medium	15	17	25	27
	High	12	15	20	25



**WESTERN USA**

GMT	WESTERN USA							
	PST	N	NE	E	SE	S	SW	NW
0000	4:00	30*	40	20	10	12	10	10
0100	5:00	20	40	20	10	12	10	10
0200	6:00	20	40	20	12	12	10	10
0300	7:00	30	40	20	15	12	10	12
0400	8:00	30	40	20	20*	12	15	15
0500	9:00	40	40	30	20	15	15	20
0600	10:00	40	40	30	20	20*	20	20
0700	11:00	40	40	30	20	20	20	20
0800	12:00	40	40	30	20	20	20	20
0900	1:00	40	40	30	20	20	20	20
1000	2:00	40	40	30	20	20	20	20
1100	3:00	40	40	30	20	20	20	20
1200	4:00	40	40	30	20	20	20	20
1300	5:00	40	30	15	20	30	30	20
1400	6:00	40	20	12	15	30	30	20
1500	7:00	40	20	10	12*	20	20	20
1600	8:00	40	20	10	10	15	20	20
1700	9:00	40	20	10	10	12	20	20
1800	10:00	40	20	10	10	12	20*	20
1900	11:00	40	20	10	10	12	15	20
2000	12:00	40	30	12*	10	12	12	15
2100	1:00	40	40*	12	10	12	12	15
2200	2:00	40	40	15	10	12	10	12
2300	3:00	40	40	15	10	12	10	12

**MID USA**

GMT	MID USA							
	MST	N	NE	E	SE	S	SW	NW
0000	5:00	40	40	20	10	12	10	10
0100	6:00	30	40	20	12	12	10	12
0200	7:00	30	40	20	15	12	12	15
0300	8:00	30	40	20	15	15	15	20
0400	9:00	40	40	20	20	20*	15	20
0500	10:00	40	40	30	20	20	20	20
0600	11:00	40	40	30	20	20	20	20
0700	12:00	40	40	30	20	20	20	20
0800	1:00	40	40	30	20	20	20	20
0900	2:00	40	40	30	20	20	20	20
1000	3:00	40	40	30	20	20	20	20
1100	4:00	40	30	15	30	30	30	20
1200	5:00	40	20	12	20	20	30	20
1300	6:00	40	20	10	15	20*	20	20
1400	7:00	40	20	10	12*	15	20	20
1500	8:00	40	20	10	10	15	20	20
1600	9:00	40	20	10	10	15	20	20
1700	10:00	40	20	10	10	12	20	20
1800	11:00	40	20	10	10	12	15	20
1900	12:00	40	20	10	10	12	15	20
2000	1:00	40	30	12*	10	12	12	15
2100	2:00	40	40*	12	10	12	12	15
2200	3:00	40	40	15	10	12	10	12
2300	4:00	40	40	15	10	12	10	12

**EASTERN USA**

GMT	EASTERN USA							
	EST	N	NE	E	SE	S	SW	NW
0000	7:00	40	40	20	12	12	12	12
0100	8:00	40*	40	20	15	12	15	15
0200	9:00	40	40	20	15	15	20	20
0300	10:00	40	40	20	20	20*	20	20
0400	11:00	40	40	20	20	20	20	20
0500	12:00	40	40	30	20	20	20	20
0600	1:00	40	40	30	20	20	20	20
0700	2:00	40	40	30	20	20	30	20
0800	3:00	40	40	30	20	20	30	20
0900	4:00	40	40	30	20	20	30	20
1000	5:00	40	30	15	30*	30	30	20
1100	6:00	40	20	12	20	30	30	20
1200	7:00	40	20	10	15	20	30	20
1300	8:00	40	20	10	12	15	20	20*
1400	9:00	40	20	10	12	15	20	20
1500	10:00	40	20	10	10	15	20	20
1600	11:00	40	20	10	10	12	20	20
1700	12:00	40	20	10	10	12	20	20
1800	1:00	40	20	10	10	12	15	20
1900	2:00	40	20	10	10	12	15	20
2000	3:00	40	30	12*	10	12	12	15
2100	4:00	40	40	15	10	12	12	15
2200	5:00	40	40	15	10	12	10	12
2300	6:00	40	40	20	10	12	10	12

The italicized numbers signify the bands to try during the transition and early morning hours, while the standard type provides MUF during "normal" hours.  
 \*Look at next higher band for possible openings.



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throughout the month, but especially good around mid-month.

No significant meteor showers occur during February. The full moon is on the 2nd and lunar perigee is on the 4th.

### band-by-band summary.

*Ten, twelve, fifteen, and twenty meters* will be open from morning to early evening almost every day, and to most areas of the world. The openings on the higher of these bands will be shorter — to the southern hemisphere — and will occur closer to local noon. Transequatorial propagation on these bands will more likely occur toward evening during conditions of highest solar flux and a disturbed geomagnetic field.

*Thirty and forty meters* will be useful almost 24 hours a day. Daytime conditions will resemble those on 20 meters, except that skip distances and signal strength may decrease during midday on days that coincide with the higher solar flux values. Nighttime DX will be good except after days of high MUF conditions and during geomagnetic disturbances. Look for DX from unusual places on east, north, and west paths during daytime and southern paths at night. The usable distance is expected to be somewhat less than 20 in daytime and greater than on 80 at night.

*Eighty and one-sixty meters* will exhibit short-skip propagation during daylight hours and lengthen for DX at dusk. These bands follow the darkness regions opening to the east just before your sunset, swinging more to the north-south near midnight and ending up in the Pacific areas during the hour or so before dawn on the path of your interest. The 160-meter band opens later and ends earlier than the 80-meter band.

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\*Can be used without radials.  
\*Feed line can be buried if desired.

\*Permanent or Portable Use

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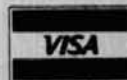
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FL-32 500 Hz CW filter	59.50	
EX-243 Electronic keyer unit	50.00	
IC-745 9-band xcvr w/1.30 MHz rcvr	999.00	769 <sup>95</sup>
PS-35 Internal power supply	160.00	144 <sup>95</sup>
EX-241 Marker unit	20.00	
EX-242 FM unit	39.00	
EX-243 Electronic keyer unit	50.00	
FL-45 500 Hz CW filter (1st IF)	59.50	
FL-54 270 Hz CW filter (1st IF)	47.50	
FL-52A 500 Hz CW filter (2nd IF)	96.50	89 <sup>95</sup>
FL-53A 250 Hz CW filter (2nd IF)	96.50	89 <sup>95</sup>
FL-44A SSB filter (2nd IF)	159.00	144 <sup>95</sup>
HM-10 Scanning mobile microphone	39.50	
SM-6 Desk microphone	39.00	
HM-12 Extra hand microphone	39.50	
MB-12 Mobile mount	19.50	



IC-751 9-band xcvr/1.30 MHz rcvr	1399.00	1089
PS-35 Internal power supply	160.00	144 <sup>95</sup>
FL-32 500 Hz CW filter (1st IF)	59.50	
FL-63 250 Hz CW filter (1st IF)	48.50	
FL-52A 500 Hz CW filter (2nd IF)	96.50	89 <sup>95</sup>
FL-53A 250 Hz CW filter (2nd IF)	96.50	89 <sup>95</sup>
FL-33 AM filter	31.50	
FL-70 2.8 kHz wide SSB filter	46.50	
HM-12 Extra hand microphone	39.50	
SM-6 Desk microphone	39.00	
RC-10 External frequency controller	35.00	
MB-18 Mobile mount	19.50	

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FL-32 500 Hz CW filter	59.50	
FL-34 5.2 kHz AM filter	49.50	
BC-10A Memory back-up	8.50	
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CF-1 Cooling fan for PS-15	45.00	
EX-144 Adaptor for CF-1/PS-15	6.50	
PS-30 Systems p/s w/cord, 6-pin plug	259.95	234 <sup>95</sup>
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AT-500 500W 9-band auto. antenna tuner	449.00	399 <sup>95</sup>
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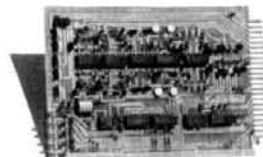
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# quartz crystal resonators

## Learn how to specify crystals using frequency/temperature relationships

**This article provides** tools for specifying, testing, and controlling the parameters of piezo-electric crystals. This data is designed to allow you to specify your requirements exactly to the crystal supplier. Also included are TI-55-II calculator programs showing examples that reduce the burden of calculations.

The article is based on practical experience with thousands of crystals used in the communications industry. Because of the competitive nature of the business and the large quantities involved, crystals must be both low in cost and usable, in that they must be capable of being placed on the specified frequency and remain on frequency (within the limits specified) despite changes in both time and temperature.

### the crystal impedance meter

When crystals are ordered from catalogs, problems frequently arise. Invariably the crystals quoted are to a military specification. There is nothing wrong with this as long as the circuit in which the crystal has to work matches it and provides the exact conditions specified. In practice this is generally not the case, and as a result, crystals that arrive may be within the specifications when tested in the standard Crystal Impedance (CI) meter, but may not meet your requirements when used in the actual oscillator circuit.

A quick look at some typical crystals listed in a vendor's catalog can give us some clues. We find among the specifications a variety of capacitances quoted. The values shown are frequently relics from the days of vacuum tubes and are used in the CI meter, selectable by a switch. This is all very convenient; the CI meter, however, looks at the crystal and measures it

as an impedance — hence its name, “crystal impedance” meter. It is therefore not operating under the conditions that an oscillator places on it. You will also note that some crystals are series resonant. In this case, there is no loading capacitor, because the crystal is being driven and is operating into a purely resistive load. These crystals are thus on frequency only if used under those conditions.

As we go above 20 MHz, we get into the realm of overtone crystals. These crystals are, however, not an exact third or fifth or higher multiple of the fundamental. If the use of multipliers is to be avoided, these crystals can serve a very useful purpose, but there are advantages and disadvantages that must be considered.

### example using 10-MHz crystal

We will now look at a typical requirement and consider a crystal that operates at 10 MHz in the parallel or antiresonant mode. (The series configuration is referred to as the resonant mode.) The crystal will therefore operate with a loading capacitance of 20 pF and in the fundamental mode. The crystal cut will typically be AT-cut, operating temperature 78.8 degrees F (26 degrees C) and frequency tolerance  $\pm 20$  ppm (other specifications we will consider later.) After obtaining samples from three different vendors and measuring them in the CI meter, we found each crystal to be at 10.000150 MHz, thus 15 ppm high. All crystals meet specifications, appear to be identical. However, all are not identical because the compliance,  $C_S$  has values of 0.01, 0.02, and 0.04 pF, respectively. ( $C_S$ ,  $L$ , and  $R$  are inherent in the crystal.) **Figure 1** shows the electrical equivalent; this is the crystal without any electrodes attached. Inductance  $L$  is the electrical equivalent of the crystal mass. Capacitor  $C_S$  is the compliance and  $R$  is due to the losses by mechanical friction of the crystal. This electrical circuit is series resonant. **Figure 2** shows the crystal with its deposited electrical contacts. This is achieved by placing a small spot of a conducting material, such as silver, on each

By Peter Boddaert, 11 Blossom Road, Braintree, Massachusetts 02184



table 1.

			crystal 1			
$C_S$ (pF)	$C_L$ (pF)	$C_S/2C_L$ (pF)	$F_S$ (MHz)	$F_P$ (MHz)	$\Delta F$ (Hz)	L (mH)
0.01	31	0.0001613	9.998243	9.999855	- 145	
0.01	26	0.0001923	9.998243	10.000166	+ 166	25.339
0.01	21	0.0002381	9.998243	10.000624	+ 624	
total pulling = 769 Hz = $\pm 38.5$ ppm						
			crystal 2			
0.02	31	0.0003226	9.996310	9.999535	- 466	
0.02	26	0.0003845	9.996310	10.000154	154	12.674
0.02	21	0.000476	9.996310	10.001068	1068	
total pulling = 1533 Hz = $\pm 76.665$ ppm						
			crystal 3			
0.04	31	0.0006452	9.992487	9.998934	- 1068	
0.04	26	0.0007692	9.992487	10.000174	+ 176	6.342
0.04	21	0.0009524	9.992487	10.002004	+ 2,004	
total pulling figure = 2,004 + 1066 = 3070 Hz = $\pm 153.5$ ppm						

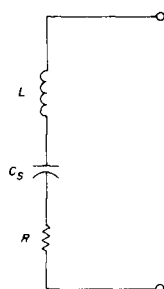


fig. 1. Crystal blank showing relationship of parameters inherent in the crystal: compliance,  $C_S$ ; electrical equivalent of the crystal mass,  $L$ ; and losses caused by mechanical friction of the crystal,  $R$ .

side and making electrical connections to these. As a result a capacitor is now formed, which together with the holder  $C$ , appears in parallel with the series resonant circuit, producing a parallel or antiresonant circuit. This capacitance is shown as  $C_P$  with a typical value of 6 pF.  $C_L$  is the load capacitance of 20 pF. The crystal thus sees the sum of  $C_P$  and  $C_L = 26$  pF as a total load capacitance. In a practical circuit  $C_L$  is usually made variable so that the oscillator can be adjusted to frequency. A trimmer capacitor typically provides a minimum variation from 15 to 25 pF. Thus the actual load capacitance can vary between 21 and 31 pF.

We will now calculate the pulling figure or pulling ability of each crystal using the above values of loading  $C$  for each of the three crystals. We will also calculate the series resonant frequency,  $F_S$ , and the value for  $L$ . (See table 1.)

A convenient formula for parallel-resonant frequency is

$$F_P = F_S [1 + (C_S/2C_L)] \quad (1)$$

We see that the pulling ability or the ability to place the oscillator on frequency, is greatly influenced by  $C_S$ . Failure to control its value can result in being unable to place units on frequency without making modifications or, if the  $C_S$  is large such as in crystal 3, the pulling ability can become excessive. Such crystals are prone to frequency jump more so than those that have a smaller value of  $C_S$ . It must be remembered that *all* crystals have spurious responses not too far removed from the desired frequency. Such spurs can show up under certain conditions such as when a change in temperature occurs. A simple rule of thumb is: a crystal has a maximum pulling ability of 100 ppm.

We find that crystal 2 meets our requirement of being able to set it to frequency with a sufficient amount of overlap at each end. Crystal 1 would also be suitable; however, at the low end, things are tight. Allowing for component variations in production, together with the fact that the crystal frequency could be higher by another 50 Hz and still be within specifications, it would be desirable to be able to reject those at the incoming inspection. A simple solution to this problem is to specify pulling ability rather than the loading capacitance. The crystal specification would include:

- The frequency.
- Pulling ability in the test circuit (minimum =  $\pm 35$  ppm, maximum =  $\pm 85$  ppm).
- Approximate loading capacitance (*for reference only*), 20 pF.

There is, therefore, no reference to frequency tolerance because this is now taken care of by the pulling ability. In addition, the value of the loading capacitance is now used as a general guideline rather than an absolute value.

Of course, the vendor must now be supplied with a test circuit. This will consist of the complete oscillator plus all of its associated circuitry; an isolating stage, mixer, and such. It must be identical with the production units. Keep in mind that any test equipment such as a frequency counter connected to the circuit will have some influence on it, so the coupling must be as loose as possible to minimize these effects. Also be aware that any tuned circuits may have some effect on the frequency. Before shipping the test circuit to your supplier, check for the correlation between it and the in-house standard. There are bound to be some variations between them, and allowance must be made for this.

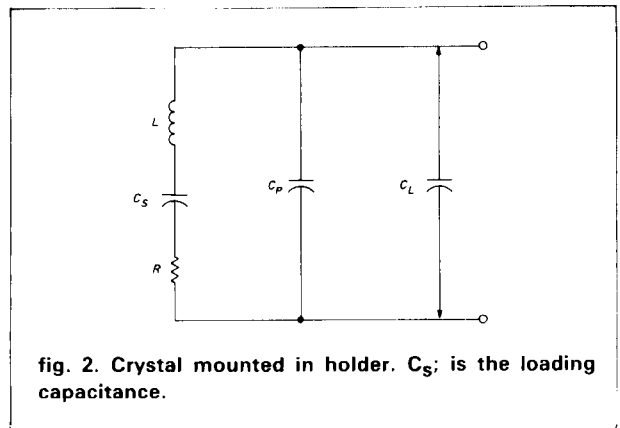
### the overtone crystal

As mentioned, the overtone crystal operates on an odd harmonic of its resonant frequency such as third, fifth, seventh and higher. These crystals are more frequently employed in the series-resonant mode (although they can, of course, also operate in the parallel mode).  $C_S$  is extremely small. For example, in a fifth overtone crystal,  $C_S$  is on the order of 0.0005 pF at 70 MHz. Hence these crystals are much more difficult to pull on frequency by using a capacitor and consequently, are relatively unaffected by changes in the rest of the circuit because of temperature variations. With these crystals, however, a test circuit should be used and supplied to the vendor.

### drive level

In general, crystal levels should be kept low. Some manufacturers specify a maximum level for AT-cut crystals operating in the fundamental mode, as 5 milliwatts. But whatever the maximum level quoted, it is better and safer to stay well below that value for a number of reasons:

- Excessive drive levels can break the crystal.
- The frequency stability is poor because of crystal heating, which causes excessive drifting.
- The crystal is much more susceptible to jump frequency or to operate on one of the crystal spurs, or to deliver an output at two or more frequencies simultaneously. These effects are most likely to show up with temperature variations.
- Note that the drive level will have some effect on the frequency; generally, doubling drive level will cause 2 ppm change.



### frequency-temperature characteristics

The AT-cut crystal has been cut at an angle of 35 degrees. **Figure 3** shows the frequency/temperature/angle-of-cut characteristics. Note that the turnover points are placed almost symmetrically on either side of the center point, 79 degrees F (26 degrees C). For example, with the cut at +20 minutes, the upper turnover point (UTP) is at 223 degrees F (106 C) and the lower turnover point (LTP) is at -47 degrees F (-44 C). Thus at 144 degrees F (80 C) and -126 degrees F (-70 C), they are on either side of the center point.

At times, then, one would specify these points — for example, if the crystal were to be placed in an oven that operates at, say 176 degrees F (80 degrees C). It would then be a good policy to have the crystal *on frequency at the turnover point* of 176 degrees F (80 C), for at that point the rate of change is least, thus improving frequency stability. Bear in mind, however, that components that are not temperature controlled, but form a part of the frequency-determining network, will still have an influence on frequency stability; thus, if at all possible, they too should be inside the oven.

Another frequently called specification states that the frequency must be within  $\pm 10$  ppm over the temperature range of 158 degrees F (70 C) to -22 degrees F (-30 C). Inspection of **fig. 3** shows that the cut at +4 minutes can meet this, but only barely. There is no margin for error in the angle of cut or for external component changes or tolerances. As a consequence, in the test area, the rejection rate is likely to be high. Generally, oscillators of this nature incorporate some form of temperature correction circuit consisting of thermistors or varactor diodes.

Unfortunately, these circuits invariably have to be adjusted during test, thus causing an added expense.

### using NTC capacitors

**Figure 4** shows a typical oscillator. Assuming the capacitances due to the transistor are small and can be ignored, we have a 20 pF loading capacitance made

table 2. Results.

temperature	-2.0 F (-19 C)	25 F (-4 C)	52 F (11 C)	79 F (26 C)	106 F (41 C)	133 F (56 C)	160 F (71 C)
F <sub>P</sub> (MHz)	9.999804	9.999879	9.999954	10.000031	10.000109	10.000189	10.000270
ΔF (ppm)	-19.550	-12.137	-4.589	3.045	10.914	18.866	26.951
C <sub>L</sub> (pF)	21.755	21.059	20.385	19.732	19.101	18.490	17.899

table 3. Corrected figures.

temperature	-2.0 F (-19 C)	25 F (-4 C)	52 F (11 C)	79 F (26 C)	106 F (41 C)	133 F (56 C)	160 F (71 C)
ΔF (ppm)	-22.595	-15.182	-7.634	0	7.869	15.821	23.906

up by the trimmer in series with the two 150-pF capacitors. Most mobile radio equipment is required to operate over the temperature range of -22 degrees F (-30 degrees C) to 158 degrees F (70 C). Thus with a total temperature change of 180 degrees F (100 C) the N2200 capacitors will change by: TC × change in degrees F × 5/10,000 × 9 equals percent. (TC × change in degrees C/10,000 = percent), where TC is the temperature coefficient. Thus 2200 × 100/10,000 = 22 percent, so that the total value of the two 150-pF capacitors in series = 75 ± 11 percent. At -22 degrees F (-30 C) the capacitance is 83.25 pF; at 158 degrees F (70 C) it is 66.75 pF.

The trimmer, which has a value of 27 pF, will change by 7.5 percent over the temperature range, thus at -22 degrees F (-30 C) it will be 28.01 pF and at 158 degrees F (70 C) it will be 25.99 pF. The total C that the crystal thus works into at 158 F (70 C) is the series combination of 66.75 + 25.99 pF in parallel with a C<sub>P</sub> of 6 pF, or a total of 18.71 + 6 = 24.71 pF. At -22 degrees F (-30 C) this becomes 20.96 + 6 pF = 26.96 pF.

If we use these capacitors in conjunction with crystal 2, which has a C<sub>S</sub> of 0.02 pF and F<sub>S</sub> = 9.99631 MHz, we thus obtain F<sub>P</sub> at 158 F (70 C) = F<sub>S</sub> × 1.0004048 = 10.000357 MHz, and at -22 F (-30 C) = F<sub>S</sub> × 1.0003709 = 10.000018 MHz. The total frequency change thus brought about = 339 Hz, a variation of 33.9 ppm. With the help of fig. 3, we can now locate a crystal that has its turnover points at ± 17 ppm. The chart shows an 8 minutes cut to be close, with turnover points at -11.2 degrees F and 168.8 degrees F (-24 C and 76 C, respectively) and a frequency variation of + and -20 ppm. The frequency changes due to the crystal would thus be reduced to approximately ± 3 ppm by the use of NTC capacitors, a very worthwhile improvement obtained without any increase in cost or number of components. Of course, the example given here is not the only combination. Had we

chosen crystal 3, with a C<sub>S</sub> of 0.04 pF, we would have obtained twice as much pulling ability, and thus use capacitors with a smaller NTC. Using a 12 minute angle places the turnover points further out thus extending the usable temperature range of the oscillator. Do not, however, lose sight of the fact that any circuit variations brought about by temperature changes will have an effect on the frequency so that bypass capacitors, layout and component placement, and good engineering principles must be taken into account.

### long-term stability

Some manufacturers publish figures for their crystals. In general the cold weld type holder will have better long-term stability. It is not easy to determine as it is a matter of time; however, to achieve the greatest stability the oscillator should operate continuously. It should also be subjected to a program of temperature cycles with the oscillator operating before setting it to frequency. How much aging can one expect? It is not unreasonable to look for a ± 3 ppm/year figure, which in most applications is very acceptable.

### resistance and temperature

The series resistance of the AT-cut crystal tends to go down in value as the frequency increases when operating in the fundamental mode. With overtone-mode crystals the reverse occurs. In the range of 5 to 20 MHz, a maximum value of 50 ohms is reasonable. Overtone crystals tend to have series R values about 50 percent higher. The resistance tends to be temperature sensitive and can easily double in value at 158 F (70 C). In some cases this could lead to oscillator failure or to a considerable reduction in output power. Specifying the maximum R over the operating temperature range rather than at 79 F (26 C) can avoid any misunderstandings with the manufacturer over this matter. Keep in mind, however, that over-specifying costs money. The tighter the specifications, the

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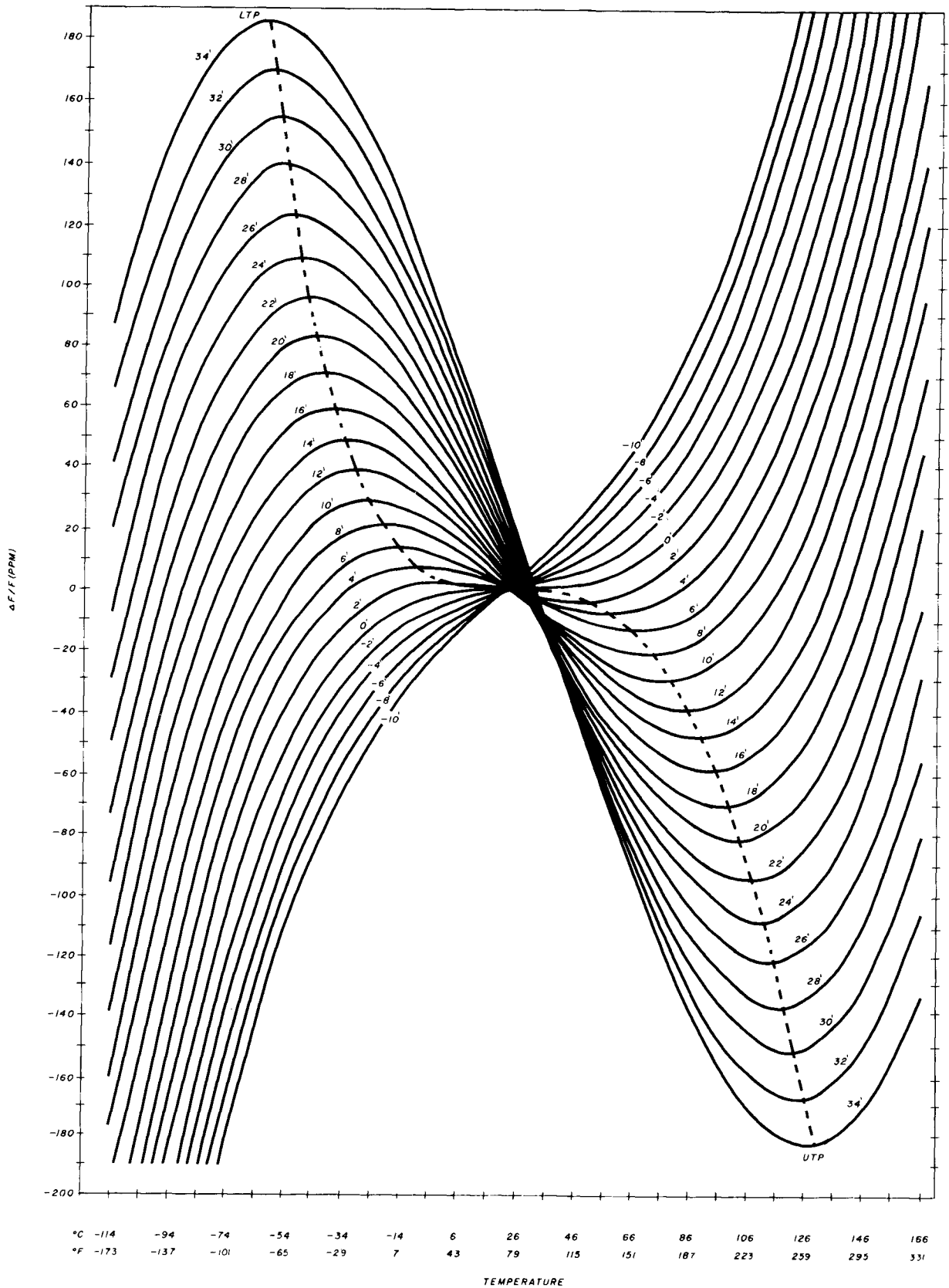
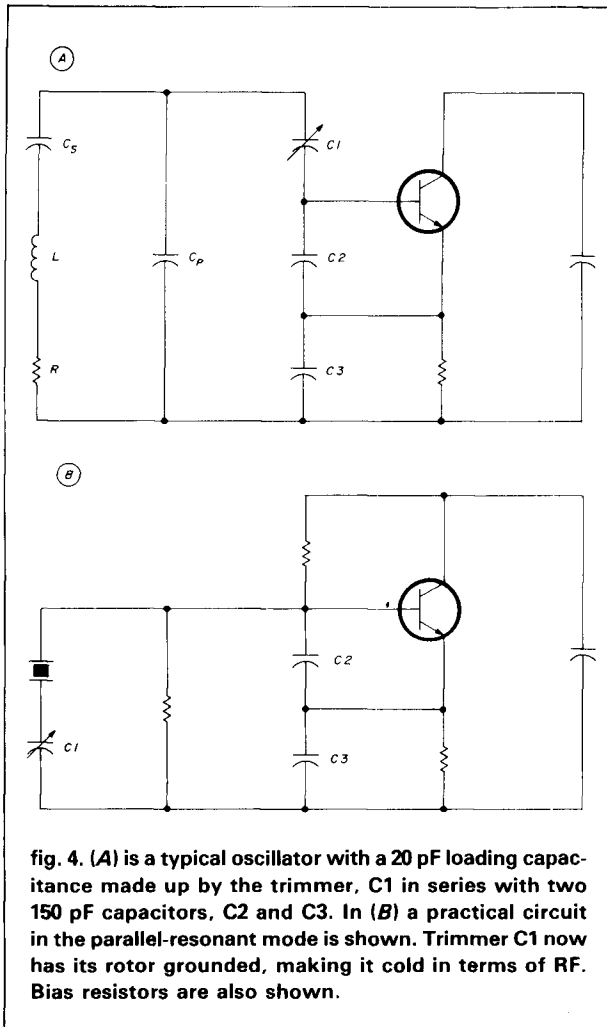


fig. 3. Frequency/temperature angle of cut characteristics for quartz crystal resonators. LTP and UTP are respectively lower and upper turnover points. Chart is for AT-cut crystals.





more expensive the product. Very low series R is also possible, which in some cases can lead to oscillator squegging. Placing a lower limit on the R value can avoid this problem.

### spurious responses

As mentioned earlier, all crystals have a number of resonances at unwanted frequencies and in some instances located close to the desired frequency. In some situations this can present a problem, with the oscillator suddenly jumping to one of these. A consultation with the vendor on this matter and a thorough testing of the initial design for this potential trouble is most desirable. If necessary the spurious response characteristics of the crystal should be included in the specifications. Experience shows that these precautions can save a lot of headaches later on.

### vendor selection

The vendor is most important; good rapport is essential. Make it clear at the onset that you will not accept units that fail to meet the specifications and

that he owns *all* rejects no matter how large the quantity. Also let him know that you intend to conduct inspection tests for compliance to specifications. For small quantities, every unit will be tested; for large quantities testing will be conducted on a sampling basis. The sampling method plus the amount of rejects found in the sample size before rejection should be explained and agreed upon by all concerned, because this will be part of the purchase contract.

Crystal manufacturers tend to specialize; consequently, the vendor who makes excellent low-frequency crystals may not produce the best high-frequency crystals. This can be especially true for overtone crystals so make sure that you select a vendor who demonstrates both the ability and willingness to produce crystals that consistently meet all your requirements. It is a mistake to press a supplier to make something that he is not really comfortable or experienced with; sooner or later, things will go wrong, spoiling a good relationship.

Today, computers and software that will determine the pulling ability of the crystals and print out a histogram of the results as well are easily available. A copy of this information sent to the supplier will enable him to make any slight modifications to his next production run if necessary.

### determining $F_p$ , $\Delta F$ , $C_L$

We have looked at quartz crystals in general and at some of the desirable parameters. I also proposed the use of NTC capacitors to compensate the frequency deviation of the crystal with temperature. I then showed that pulling ability is important, much more so than is generally realized. By placing a minimum/maximum limit on it, we get the Series C, a property of the crystal under manufacturing control, ensuring consistency of the product as well as the ability to place the crystal on frequency in our circuit and to apply temperature compensation.

In the previous example the minimum/maximum pulling ability was specified as  $\pm 35$  ppm and  $\pm 85$  ppm. Statistically the mean is thus  $\pm 60$  ppm. Inspection of the formula for  $F_p$  and the example crystals 1, 2, and 3 shows that the pulling ability of the crystal is directly proportional to the value of  $C_S$ .

Taking crystal 1 as an example with  $C_S$  at 0.01 pF and pulling ability at  $\pm 38.5$  ppm, then  $C_S$  for the average crystal with  $\pm 60$  ppm pulling ability =  $(60/38.5) \times 0.01 = 0.016$  pF. We can now also calculate  $F_S$  for this crystal using the formula for  $F_p$  and transposing:  $F_S = F_p/[1 + C_S/2 C_L]$ , which, with  $F_p = 10$  MHz and  $C_L = 26$  pF = 9.996923 MHz. As this is the crystal we will be working with, and for easy reference, we place the parameters on one line:  $F_S = 9.996923$  MHz,  $C_S = 0.016$  pF,  $F_p = 10.000,000$  MHz,  $C_L + C_p = 26$  pF.

**table 4. Results.**

temperature	-2.0 F (-19 C)	25 F (-4 C)	52 F (11 C)	79 F (26 C)	106 F (41 C)	133 F (56 C)	160 F (71 C)
crystal $\delta'$ (ppm)	21	18	10	0	-10	-17	-21
corrected (ppm)	-22.595	-15.182	-7.634	0	7.869	15.821	23.906
error (ppm)	-1.595	2.818	2.366	0	-2.131	-1.179	2.906

**table 5. Results.**

temperature	2.0 F (-19 C)	25 F (-4 C)	52 F (11 C)	79 F (26 C)	106 F (41 C)	133 F (56 C)	160 F (71 C)
$F_p$ (MHz)	9.999905	9.999945	9.999985	10.000026	10.000067	10.000108	10.000150
$\Delta F$ (ppm)	-9.474	-5.485	-1.460	2.604	6.704	10.842	15.017
$C_L$ (pF)	20.817	20.463	20.115	19.773	19.437	19.107	18.782

**table 6. Corrected figures.**

temperature	-2.0 F (-19 C)	25 F (-4 C)	52 F (11 C)	79 F (26 C)	106 F (41 C)	133 F (56 C)	160 F (71 C)
$\Delta F$ (ppm)	-12.078	-8.089	-4.064	0	4.1	8.238	12.413

Next, determine and tabulate the values of  $C_L$ ,  $F_p$ , and the change of  $F_p$  (from that at 79 degrees F (26 C) in frequency and ppm with temperature. Except for the frequency, it serves no practical purpose to tabulate beyond three decimal points; similarly, there is little to be gained in making the temperature steps closer than 27 degrees. An operating range of 81 degrees F (45 C) above and below 79 degrees (26 C) is sufficient for most applications.

### capacitors with N2200 temperature coefficients

In the following example,  $C_1$ ,  $C_2$ , and  $C_3$  have an N2200 temperature coefficient. And since they are all in series (fig. 4A) it is a simple matter to calculate  $C_L$  at 79 degrees F (26 C).  $C_L = 1/(1/27 + 1/75) = 1/(0.0370 + 0.0133) = 19.853$  pF. Next, calculate the new value of  $C_L$  at a temperature 27 degrees F (15 C) below 79 degrees F (26 C). We can use either the formula above or use the calculator program shown in appendix A. As this calculation is very simple (there being no mixture of TCs) we will use the formula, thus:  $2200 \times 15/10,000 = 3.3$  percent. The new capacitive value is  $= 19.853 \times 1.033 = 20.508$  pF. That is, for every 27 F (15 C) degree decrease in temperature, the capacitance increases by 3.3 percent. Conversely, the capacitance decreases in value by 3.3 percent for every 27 F (15 C) degree increase in temperature. Hence the multiplier is then  $1/1.033 = 0.968$ . It is this value that is used in the calculator program in appendix B as the capacitance multiplier.

To use the program we enter in lines 02, 03, 04 the capacitance multiplier 968 plus the other values as shown (which belong to the crystal.) We then start

calculations by entering into the calculator display the value of  $C_L$  at 15 degrees C below the lowest temperature of interest, thus in the example at  $-60$  C ( $\Delta T$ ),  $(-29$  F or  $-34$  C)  $= 1.132 \times 19.853 = 22.47$  pF. Note that the value of  $C_L$  at 79 degrees F (26 C) (19.853 pF) is not used in the program.

We now have the calculated values of  $F_p$  in MHz at every 15-degree C interval as well as the change in  $F_p$  ( $\Delta F$ ) in ppm (table 2). We find at the 26-degree C point an error of 3.045 ppm. In practice, correction is by adjusting  $C_1$  to pull it on frequency. On paper, we do it by subtracting 3.045 ppm from each figure (see table 3).

Our next step is to look at the curves of figs. 3 and 5. These are the frequency/temperature curves for AT-cut crystals. Note the dashed line which intersects the upper and lower turnover points with the various angles of cut. For our purpose, fig. 5 is more convenient to use. Now project on this set of curves, at the  $-2.2$  F ( $-19$  C) point, the  $-22.595$  ppm obtained from the corrected figures in table 3, but with a change of sign. Thus as a + quantity, it intersects the LTP just above the 8 minute cut and in the other direction, at 160 F (72 C), it is close to intersecting the UTP of a 9 minute cut.

A crystal with an LTP at  $-2.2$  F ( $-19$  C) of 22 ppm would appear to be our best bet, (approximately an 8 minute cut). Tabulating the figures for this crystal and subtracting the corrected figures from them, we obtain the results shown in table 4.

We have thus improved the frequency/temperature performance of the system from a maximum variation of 42 ppm to one with a change of 5.037 ppm, about an 8:1 improvement.

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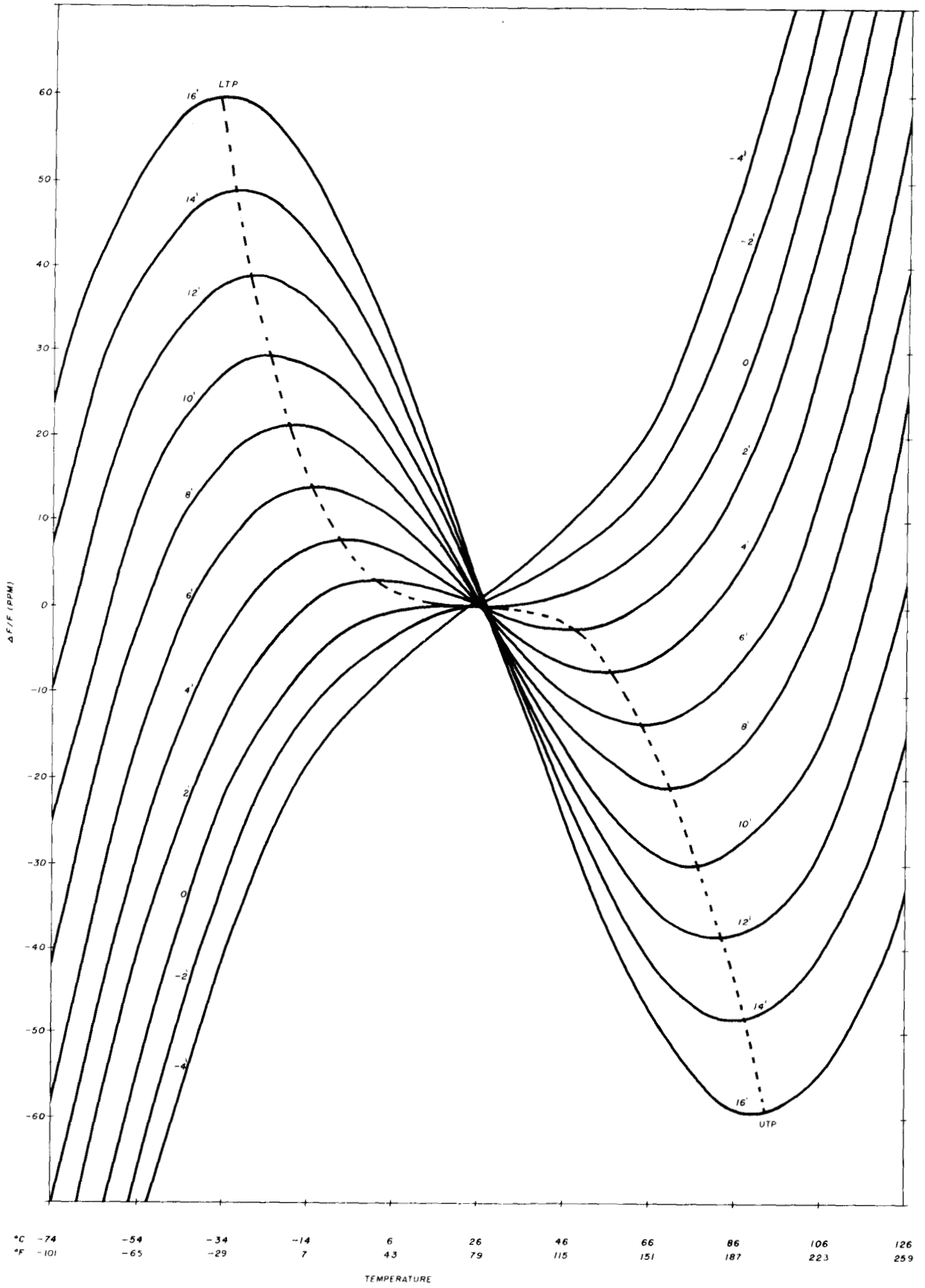


fig. 5. Frequency/temperature curves used to demonstrate crystal performance. (A text example. Chart is for AT-cut crystals.)

table 7. Results.

	- 2.0 F (- 19 C)	25 F (- 4 C)	52 F (11 C)	79 F (26 C)	106 F (41 C)	133 F (56 C)	160 F (71 C)
crystal 5.5' (ppm)	12	11	7	0	- 6.5	- 11	- 12
corrected (ppm)	- 12.078	- 8.089	- 4.064	0	4.1	8.238	12.413
error (ppm)	- 0.078	2.911	+ 2.938	0	- 2.400	- 2.762	0.413

## N750 temperature coefficient material

In the next example, the TC of C1 is changed to an N750 material. Because we are now employing two different TC materials in the capacitors forming C<sub>L</sub> it is easier to make use of the program in **appendix A**. Calculate the value of C<sub>L</sub> at 15 C and at - 60 C | - 29 F (- 34 C) below 79 F (26 C). The rest of the calculations are the same as for our first example. The value of C<sub>L</sub> at 79 F (26 C) is of course, still 19.853 pF. Capacitors C2 and C3, being identical and in series, are thus treated as one capacitor of 75 pF.

temperature	52° F (11°C)	- 29° F (- 34°C)
C1 (pF)	= 27.304	28.215
C2,3 (pF)	= 77.475	84.900
C <sub>L</sub> (pF)	= 20.189	21.177

The capacitance multiplier =  $20.189/19.853 = 1.017$  and the value used in the calculator program is  $1/1.017 = 0.983$ . Start the calculations by entering into the display C<sub>L</sub> at - 29 F (- 34 C) = 21.177 pF.

We have now the calculated values of F<sub>P</sub> (in MHz) (see **table 5**) at every 15 C-degree interval, also the change in F<sub>P</sub> (ΔF) in ppm. We now correct for the shift at 79 F (26 C), by subtracting 2.604 from each reading see (**table 6**).

Turning now to the curves (**fig. 5**) locate at - 2.2 F (- 19 C) the + 12.078 ppm point. This is located just below the + 6 minutes cut, which has its LTP at 7 F (- 14 C) and at the 13.5 ppm point. Thus a crystal, having an angle of cut just a fraction below this would probably be our best bet, a cut having its LTP at: 14 F (- 10 C) degrees with + 12 ppm (approximately a 5.5 minutes cut). Tabulating the figures for this crystal and subtracting the "corrected figures" from them, we obtain the results shown in **table 7**. We have thus improved the frequency/temperature performance from a 24 ppm change to 5.848 ppm, an improvement of 4:1.

## summary

The improvement in frequency drift with temperature is considerable and obviously desirable. Instead of specifying the angle of cut, specify either the LTP or the UTP (whichever is more important), giving both the temperature and the amount of change desired from the 79 F (26 C) degree point. Since these points

are easily measured using standard test equipment, the manufacturer decides on the angle of cut. Crystals tend to show hysteresis, or inability to retrace reverse conditions, so temperature/frequency measurement should always be made from the same direction in terms of temperature.

To obtain the greatest frequency stability with temperature and time variations, and if power conservation is of secondary importance, place the complete oscillator in a temperature controlled oven, specify the crystal frequency and the UTP at the oven temperature, and allow both to operate continuously.

Where power preservation is important, such as in portable equipment, use NTC capacitors to compensate the crystal and specify the upper and lower turn-over points. Place the capacitors close to the crystal so that they also "feel" the same temperature, keeping them clear from heat generating parts.

Overtone crystals are frequently used in the resonant mode. It is generally desirable to tune out C<sub>p</sub> with an inductance to prevent oscillations at a frequency determined by this capacitance. Frequency adjustment by the addition of a small amount of inductance is possible.

## appendix A

### TI-55-II programming

Calculates capacitance with change of temperature. Requires three data memories that contain the numerical values of C, the temperature change or the temperature coefficient, and the number 1,000,000. Displays the new capacitance value.

step	key	line no.	key code	remarks
1	x	00	65	
2	RCL	01	71	
3	1	02	01	memory 1, stores TC or temperature change
4	÷	03	55	
5	RCL	04	71	
6	2	05	02	memory 2, stores 1,000,000
7	=	06	95	
8	x	07	65	
9	RCL	08	71	
10	0	09	00	
11	=	10	95	memory 0, stores the value of C
12	..	11	75	
13	RCL	12	71	
14	0	13	00	
15	=	14	95	memory 0, stores the value of C
16	±	15	94	
17	RST	16	22	displays the new value of C and resets the calculator to start
18	LRN			takes the calculator out of the learning mode.



Now, key in the value of  $C(27)$  and STO in 0. Place  $TC(750)$  in STO 1 and 1,000,000 in STO 2. Clear display and press RST. Key into the display the temperature  $-50$  C. press R/S. The display should show 28.0125, thus the capacitance increased with a reduction of  $-50$  C in temperature.

Next place into the display 50, then R/S, and the display will show 25.9875, thus a decrease in capacitance with increasing temperature. Thus, by placing the TC of the capacitor into memory 1, and with the capacitor's value stored in memory 0, we can conveniently find the new value with any change of temperature. Interchanging TC with temperature, thus placing the temperature change in memory 1 and keying the TC into the display, will show the effect of changing TC on the capacitance value with various temperature coefficients.

## appendix B

### TI-55-II programming

Calculates and displays each new value of  $F_p$ ,  $\Delta F$  from  $F_p$  at 26 C degree, and the new value of  $C_L$  (in pF). Note that F is shown in + or - ppm. Requires three data memories. Memory 0 stores the new (decremented) value of  $C_L$ , memory 1 contains  $F_S$  in MHz (to six decimal places), and memory 2 contains the value of  $F_p$  at 26 degrees C also to six decimal places.

step	key	line no.	key code	remarks	example
1	x	00	65		
2	.	01	93		
3	*	02	*		9
4	*	03	*	enter: capacitive multiplier	6
5	*	04	*		8
6	=	05	95		
7	STO	06	61	memory 0 must be empty (0) at the start	
8	0	07	00		
9	+	08	85		
10	*	09	*	value of $C_p$ (6 pF)	6
11	=	10	95		
12	x	11	65		
13	2	12	02		
14	=	13	95		
15	÷	14	55		
16	*	15	93		
17	*	16	*	value of $C_S$ (0.016 pF)	0
18	*	17	*		1
19	*	18	*		6
20	x-y	19	52		
21	+	20	85		
22	1	21	01		
23	=	22	95		
24	x	23	65		
25	RCL	24	71	enter $F_S$ in memory 1	9.996923
26	1	25	01		
27	=	26	95		
28	R/S	27	12		
29	-	28	75		
30	RCL	29	71	enter $F_p$ at 26 degrees C in memory 2	10.000000
31	2	30	02		
32	-	31	95		
33	+	32	55		
34	RCL	33	71		
35	2	34	02		
36	=	35	95		
37	2nd Eng	36	47		
38	R/S	37	12		
39	RCL	38	71		
40	0	39	00		

End of program. Automatically resets and displays the new value of  $C_L$ , which is now in memory 0.

To start, press RST, enter  $F_S$  in memory 1 and  $F_p$  in memory 2. Check that memory 0 is 0. Enter into the display the value of  $C_L$  at  $-76$  F ( $-60$  C). Example 22.474. Press R/S. Displays  $F_p$  at  $-2$  F ( $-19$  C) = 9.999804. Press R/S, display  $-19.550706$ . This is the change in frequency from  $F_p$  at 26 C =  $-19.550$  ppm. Press R/S, display = 21.754832 00; thus 21.755 pF, which is  $C_L$  at  $-2$  F ( $-19$  C). Press R/S again. This repeats the calculations, using this time  $C_L$  at  $-2$  F ( $-19$  C), calculates all the 25 F ( $-4$  C) parameters, and so on, saving a lot of repeating calculations.

## appendix C

### TI-55-II programming

To calculate  $F_p = F_S [1 + (C_S/2C_L)]$  requires four data memories that will contain the numerical values of  $C_S$ ,  $C_L$ ,  $F_S$ , and  $F_p$  at 26 C degrees in this order. In the same order will be displayed the values of  $C_S/2C_L$ ,  $F_p$  and the difference between  $F_p$  and the  $F_p$  at 79 F (26 C), thus  $\Delta F$ . Partition four memories and place the calculator in the learn mode.

step	key	line no.	key code	remarks
1	RCL	00	71	
2	0	01	00	memory 0 stores $C_S$
3	÷	02	55	
4	(	03	53	
5	2	04	02	
6	x	05	65	
7	RCL	06	71	
8	1	07	01	memory 1 stores $C_L$
9	)	08	54	
10	-	09	95	
11	R/S	10	12	displays value of $C_S/2C_L$
12	+	11	85	
13	1	12	01	
14	-	13	95	
15	x	14	65	
16	RCL	15	71	
17	2	16	02	memory 2 stores the value of $F_S$ in MHz
18	-	17	95	
19	R/S	18	12	displays the value of $F_p$ in MHz
20	-	19	75	
21	RCL	20	71	
22	3	21	03	memory 3 stores $F_p$ at 26 C degree point, (thus with a total $C_L$ at 26 pF). Example 10.000000 MHz)
23	-	22	95	
24	RST	23	22	displays the difference between $F_p$ and the value contained in memory 3 takes calculator out of learning mode.
25	LRN			

Key in the value of  $C_S$  (0.01) and STO in 0. Place  $C_L$  (26) in STO 1,  $F_S$  in STO 2, and in STO 3. Place 10,000,000. Now press ON/C to clear the display. Check the contents of each memory for errors. If OK again clear the display and press R/S to run the program. The first stop should be  $C_S/2C_L = 0.0001923$ . Press R/S again, up comes  $F_p = 10.000166$  and finally the frequency difference at 0.0001667 MHz. Press 2nd, Fix 6, which will fix the display to 6 decimal points.

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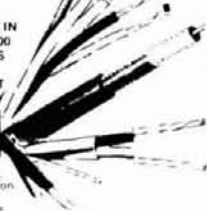
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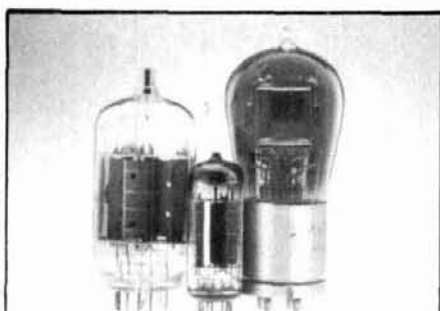
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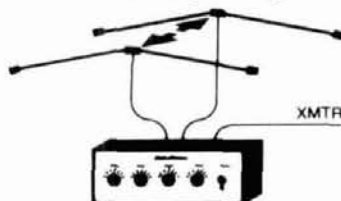
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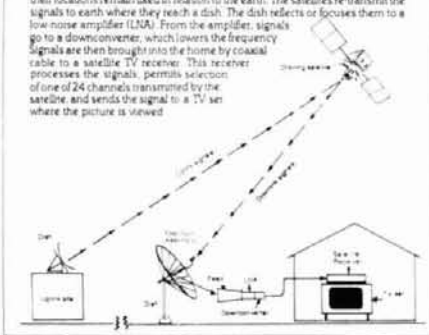
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MRF234	25W	66-88	15.00	39.00
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MRF238	30W	136-174	12.00	—
MRF239	30W	136-174	15.00	—
MRF240	40W	136-174	18.00	—
MRF245	80W	136-174	28.00	65.00
MRF247	75W	136-174	27.00	63.00
MRF250	50W	27-174	20.00	46.00
MRF260	5W	136-174	7.00	—
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MRF648	60W	407-512	33.00	69.00
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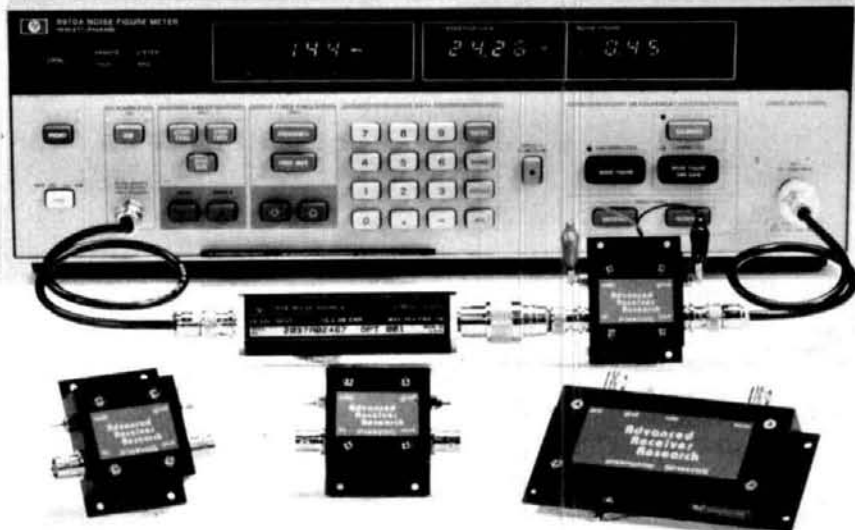


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SP50VDG	50-54	<0.55	24	+12	GaAsFET	\$109.95
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*How To Read What You Writ!* is available directly from Loraine McCarthy, Code Programs Manager, Gordon West's Radio School, 315 1/2 Ruby, Balboa Island, California 92662. The price is \$14.95. All orders are shipped by first class mail the same day. (Add \$2.00 postage and handling.) Circle #301 on Reader Service Card.

## Heathkit catalog

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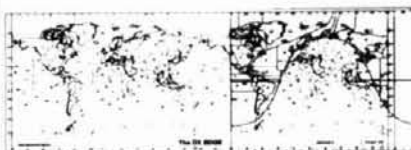
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## COMING EVENTS

### Activities — "Places to go . . ."

**CALIFORNIA:** FCC exams. Novice Extra. Sunnyvale VEC ARC (408) 255-9000 24 hour. 73, Gordon, W6NLG, VEC

**PENNSYLVANIA:** The Mercer County Amateur Radio Club invites Amateurs to socialize and exchange views at its "How To" seminar, March 22, 9 AM to 4:30 PM, Hermitage Middle School opposite Shenandoah Valley Mall, Rt. 18, Hermitage. License exams, Novice through Extra, will be given. Examinees and those under 18 years admitted free. For others admission is \$2.00. Call in on 147.75.15. For details SASE to MCARC, Box 996, Sharon, PA 16146.

**MASSACHUSETTS:** The Mt. Tom Amateur Repeater Association is having its annual Flea Market, March 2, Knights of Columbus Elder Council 69 on Granby Road, Chicopee. Doors open 8 AM to 3 PM. Food available. Reserved tables \$7.00. At the door \$8.00. Entrance fee \$1.00. Ladies and children under 12 free. For reservations: MTARA, PO Box 3494, Springfield, MA 01101.

**MINNESOTA:** The Robbinsdale Amateur Radio Club's 5th annual Midwest Madness Hobby Electronics Show, February 22, Totino Grade High School, 1350 Garden Avenue NE, Fridley, MN (suburb of Minneapolis). Admission \$3.00 advance; \$4.00 at the door. 8' flea market tables \$8.00, 1/2 tables \$4.00. Dealers, flea market, computers, satellite TV, packet radio. Talk in on 147.60.00 KJLTC repeater and 146.52 simplex. To register send SASE with fees to Robbinsdale ARC, PO Box 22613, Robbinsdale, MN 55422 or call Bob (612) 533 7354. FCC exam registration send completed Form 610, photocopies of current license and credit card plus \$4.00 payable to ARRL/VEC to: Neil McMillin, 1132 97th Place, Maple Grove, MN 55369 by January 22, 1986. Limited walk-ins.

**KENTUCKY:** Annual Glasgow Swapfest, Saturday, February 22, 8 AM at Glasgow Flea Market Building, 2 miles south of Glasgow off Highway 31E. Free parking, free coffee and a friendly gathering of hams. Admission \$2. No extra charge for exhibitors. One free table per exhibitor. Extra tables \$3.00 each. Talk in on 146.34.94. For information: N4HCO, Rt 4, Box 354, Glasgow, KY 42141.

**MASSACHUSETTS:** The Norwood ARC will hold its annual Flea Market, Saturday, February 22, Norwood Junior High School South, Washington Street. Dealer tables \$10.00. Setup 8 AM. General admission \$2.00. Open 9 AM. Plenty of free parking and facilities for the handicapped. For information or table reservations: Stan Cottrell, WA1NCV (617) 762 5184. Talk in on 146.520 and 146.895.

**ILLINOIS:** The Sterling Rock Falls Amateur Radio Society's 26th annual Hamfest, March 9, Sterling High School Fieldhouse, 1608 Fourth Avenue, Sterling. Distributors, dealers, large flea market and demonstration of Packet Radio. Free parking and space for self contained RV's. Doors open 7:30 AM. Tickets \$3.00 advance; \$4.00 at the door. Commercial tables \$5.00. Others \$3.00. For tickets, tables or information: Sue Peters, KA0GMR, PO Box 521, Sterling, IL 61081. (815) 625-9262. Talk in W9MEP 146.25/85.

**MASSACHUSETTS:** The MIT UHF Repeater Association and the MIT Radio Society offer monthly Ham Exams. All classes Novice to Extra. Wednesday, February 19, 1986, 7 PM, MIT Room 1 134, 77 Mass Ave, Cambridge, MA. Reservations requested 2 days in advance. Contact Ron Hoffmann (617) 253 5820/646-1641 or Craige Rodgers at 225 6616. Exam fee \$4.00 BRN copy of current license, 2 forms of picture ID and completed form 610 (available from FCC in Boston, 223-6609).

**VIRGINIA:** The Vienna Wireless Society will hold its 13th annual Winterfest, February 23, 8 AM, Vienna Community Center, 120 Cherry St., Vienna. Exhibits and demonstrations of new and used Amateur Radio equipment. Tailgating in the "Frostbite" parking lot. Refreshments available. For information: John Arnold, N4IXD, Chairman, 255 2076.

### Operating Events — "Things to do . . ."

**North Carolina QSO Party** sponsored by the Alamance ARC, K4EG, 1400Z February 1 to 0500Z February 2, CW and phone. Work stations once per band/mode. Mobsiles as they change county. Exchange RS(T) and ARRL section. Mail logs by 3/1/86 to North Carolina QSO Party, c/o K4EG, PO Box 3064, Burlington, NC 27215.



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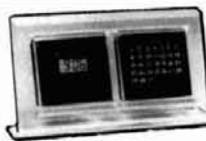
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# THE GUERRI REPORT

by Ernie Guerri, W6MGI

## millimeter waves

### Part I: the move to higher frequencies

For most Amateurs, the notion of moving to higher frequency bands means operating at or above 144 MHz. A few brave pioneers work in the microwave region — and have precious few contacts to show for it. We could be tempted to forget that for more than 40 years, there has been an avalanche of effort devoted to the development of microwave hardware and systems.

For the purposes of this discussion, "microwaves" will mean the region above 2 GHz — that is, up to about 30 GHz. This is the domain where lumped circuits fail to have physical implementation and where waveguide replaces coax in many low-loss or high-power applications. While military uses were the principal motivator for early work, commercial applications are now the driving force in the region from 2 to 18 GHz.

Band crowding is already a major issue in the microwave region. By the mid-1960s, the military had found use for nearly everything up to about 20 GHz. Then came the demands for commercial satellite uses, followed by the expansion of terrestrial links to take advantage of all the information the satellites were sending. By the early

1980s, interference was an issue in some frequency bands. The result has been a critical examination of the technologies needed to make higher frequencies available for both commercial and military applications.

These higher frequencies are known as *mm waves* — and, for convenience, are generally defined as the wavelengths from 10 mm to 1 mm (30 to 300 GHz). One of the obvious advantages of this new domain is the amount of spectrum space available: 270 GHz.

Among the advantages that mm systems offer are broad bandwidths (good for high speed data links), higher spatial resolution, less interference due to narrow antenna beams, and, at the high end of the range (near 300GHz), a favorable alternative to optical (infra-red) technologies.

Much work has already been done in this region, but the advent of computer modeling techniques is advancing the rate at which progress can be made. A major limitation on the use of mm waves has been the lack of appropriate devices, hardware, and test equipment. Within the past two years, however, there have been significant developments in each of these areas.

The generation and detection of mm waves requires the use of components and techniques that are unfamiliar to most Amateurs. Semiconductor devices are the only sources of RF power at frequencies above 30 GHz. In general, these devices take the form of negative resistance oscillators and

depend on the characteristics of special diodes. The more common of these diodes are GUNN diodes, named for the discoverer of transferred electron devices; IMPATTs (*Impact Ionization Avalanche Transit Time*); and TRAPATTs (*Trapped Plasma Avalanche Triggered Transit*).

Each of these devices has characteristics that make it best for certain applications. The tradeoffs are between frequency (of operation), power output, and noise. IMPATT diodes have been fabricated that can produce 1 watt at about 70 GHz.

Transistors will soon be available for the mm region. GaAs FETs are already being made as small signal amplifiers above 30 GHz, and it shouldn't be too long before HEMT (*High Electron Mobility*) and MESFET (*Metal on Oxide*) devices are available to 100 GHz or so. Power transistors for this region are still a few years off — but only a few. Other necessary components are being developed quite aggressively, as is test equipment. Hewlett Packard has just announced its first line of mm wave spectrum/network analyzers. Special materials and design techniques will be needed to take best advantage of the promise held by mm waves. Work is underway in each of these areas, and the results will not be more than four to five years away.

#### ham radio

**Next month:** Part II — Where Do We Go From Here?

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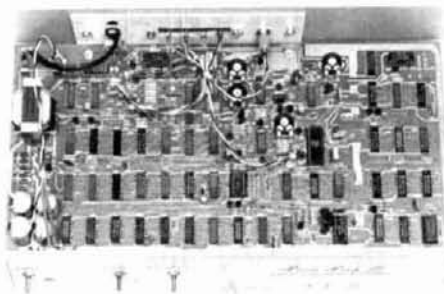
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# YAESU

*Our 30th Anniversary.*

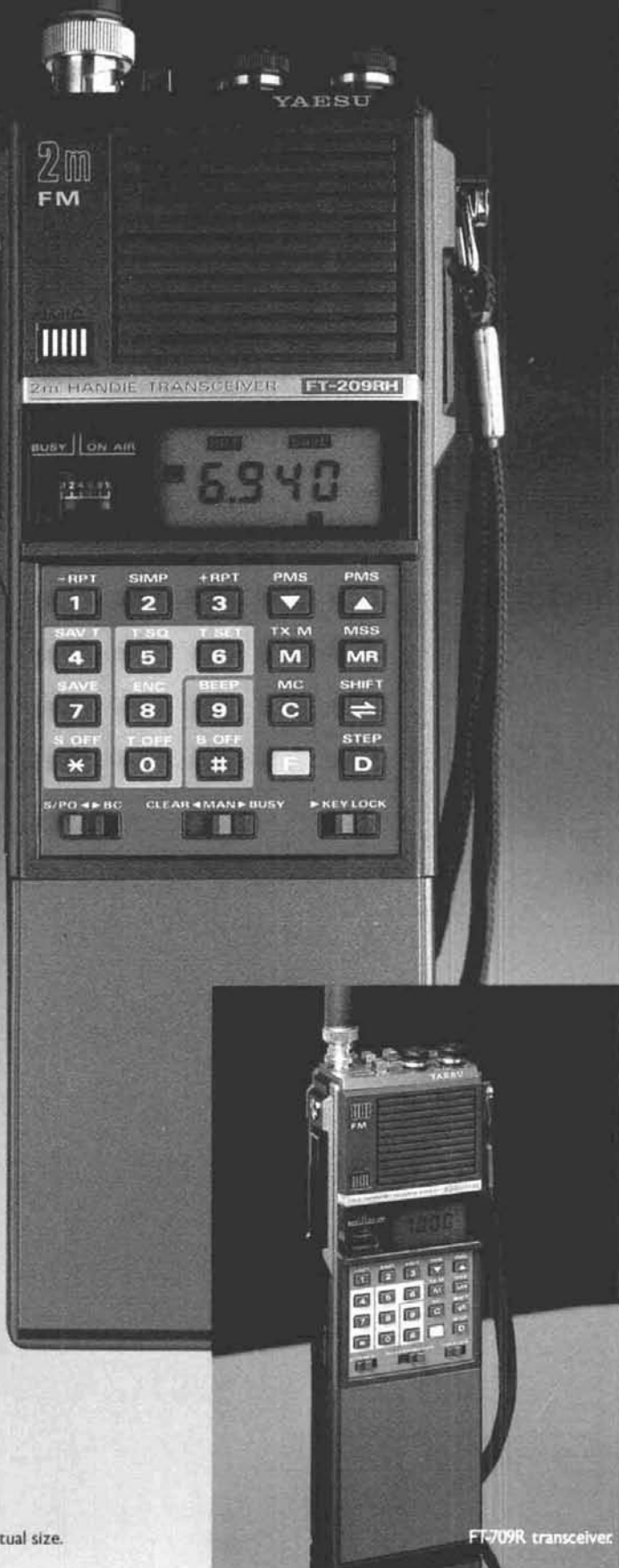
#### Yaesu Electronics Corporation

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(213) 633-4007

#### Yaesu Cincinnati Service Center

9070 Gold Park Drive, Hamilton, OH 45011  
(513) 874-3100

Prices and specifications subject to change without notice.



209RH shown actual size.

FT-709R transceiver

# KENWOOD

...pacesetter in Amateur radio

WAIT  
220 MHz  
Coming soon!

## Power-Full...70 Watts!

### TM-2570A/2550A/2530A

#### Sophisticated FM transceivers

**Kenwood sets the pace again!**

The all-new "25-Series" brings the industry's first compact 70-watt 2-meter FM mobile transceiver. There is even an *auto dialer* which stores 15 telephone numbers! There are three power versions to choose from: The TM-2570A 70-watt model, the TM-2550A for 45-watts, and the 25-watt TM-2530A.

- First 70-watt FM mobile (TM-2570A)
- First mobile transceiver with telephone number memory and auto-dialer (up to 15 telephone numbers)
- Direct keyboard entry of frequency
- Automatic repeater offset selection according to the ARRL 2-meter band plan — a **Kenwood exclusive!**
- Extended frequency coverage for MARS and CAP (142-149 MHz; 141-151 MHz modifiable)
- 23 channel memory for offset, frequency and sub-tone
- Big multi-color LCD and back-lit controls for excellent visibility

- Front panel programmable 38-tone CTCSS encoder **includes 97.4 Hz** (optional)
- 16-key DTMF pad, with audible monitor
- Center-stop tuning — **another Kenwood exclusive!**
- Frequency lock switch
- **New** 5-way adjustable mounting system
- **Unique** offset microphone connector — relieves stress on microphone cord

- HI/LOW Power switch (adjustable LOW power)
- Compact DIN size



#### Introducing... Digital Channel Link

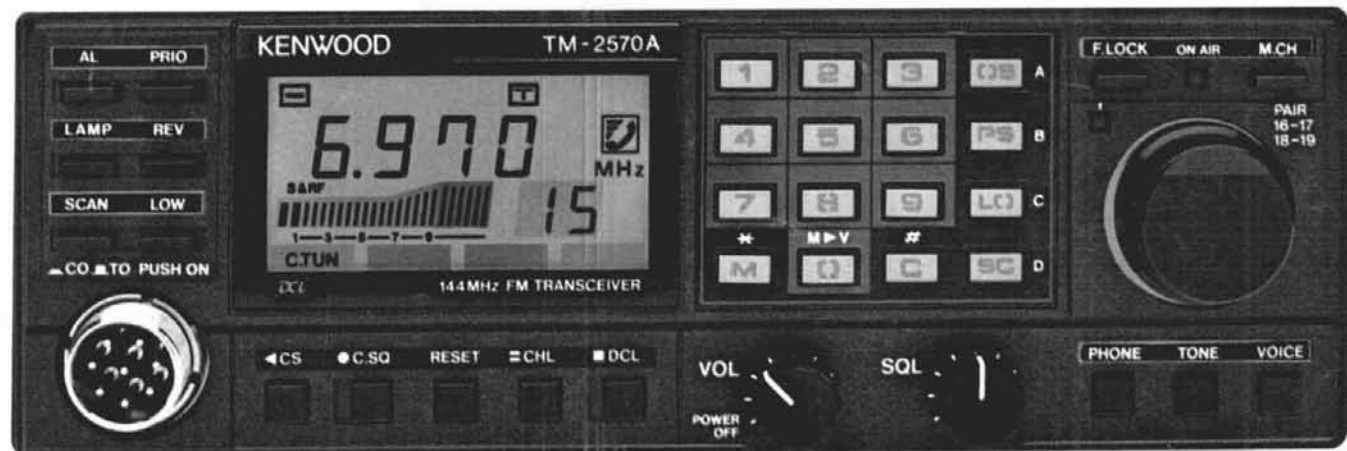
Compatible with Kenwood's DCS (Digital Code Squelch), the DCL system enables your rig to **automatically** QSY to an open channel. Now you can automatically switch over to a simplex channel after repeater contact! Here's how it works:

The DCL system searches for an open channel, remembers it, returns to the original frequency and transmits control information to another DCL-equipped station that switches **both** radios to the open channel. Micro-processor control assures fast and reliable operation. The whole process happens in an instant!

Large heatsink with built-in cooling fan (TM-2570A)



BUILT-IN  
COOLING FAN  
(TM-2570A)



#### Optional Accessories

- TU-7 38-tone CTCSS encoder
- MU-1 DCL modem unit
- VS-1 voice synthesizer
- PG-2K extra DC cable
- PG-3A DC line noise filter
- MB-10 extra mobile bracket
- CD-10 call sign display
- PS-430 DC power supply for TM-2550A/2530A

- PS-50 DC power supply for TM-2570A
- MC-60A/MC-80/MC-85 desk mics.
- MC-48 extra DTMF mic. with UP/DWN switch
- MC-42S UP/DWN mic.
- MC-55 (8-pin) mobile mic. with time-out timer
- SP-40 compact mobile speaker
- SP-50 mobile speaker
- SW-200A/SW-200B SWR/power meters
- SW-100A/SW-100B compact SWR/power meters
- SWT-1 2m antenna tuner

Actual size front panel

# KENWOOD

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Compton, California 90220

Complete service manuals are available for all Trio Kenwood transceivers and most accessories. Specifications and prices are subject to change without notice or obligation.